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POSTING IN NEW YORK: 1980 UPDATE[1]

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ABSTRACT

Data collected during a 1980 survey of wildlife-related interests of private owners of rural lands in upstate New York were analyzed to measure changes in the incidence of land posting since 1972, as well as to compare posting and nonposting landowners for a better understanding of their posting behavior. A mail-back questionnaire sent to 2,000 owners of 10 or more acres in a stratified sample of 50 rural towns resulted in an adjusted sample of 1,888 which yielded 1,295 useable returns (68.5 per cent). Of these, 48 per cent, who owned 58 per cent of the land in the sample, posted their land. The rate of increase in posting for the 1972 to 1980 period was less than half that for the 1963 to 1972 period. A leveling off of the State population and its real income during the 1970's and a sharp decline in snowmobiling are cited as factors which may have helped reduce the rate of posting.

Absentee owners totalled 43 per cent of the respondents, but only 28 per cent did not live in the same county as their rural land. A strong correlation was found between posting by absentee owners and the amount of time these owners spent on their property. Almost two-third (65 per cent) of posting landowners indicated that they would allow hunting if permission were sought. Participation in wildlife-related activities was significantly higher for posting than nonposting landowners, and posting landowners were more active in employing wildlife habitat and forest improvement practices.

Concern during the 1950's with the growing problem of restricted public access to private lands led the New York Cooperative Wildlife Research Unit to undertake in 1962 a statewide study of the incidence of and reasons for posting private land (Waldbauer, 1966). This study showed that 25 per cent of such land was posted in 1963 and that landowner-recreationist conflicts were the major reason.

A 1970 survey of rural landowners in central New York indicated a sharp rise in land posting against trespass after the early 1960's (Wilkins and Erickson, 1971). This and other information prompted another study

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by the New York Cooperative Wildlife Research Unit in 1972-73 to assess changes in the posting behavior and attitudes of landowners in New York after 1963 (Brown and Thompson, 1976). A sample of landowners in 28 of the 100 towns originally studied by Waldbauer was selected and resurveyed. The survey found that the proportion of rural acreage posted had increased from 25 to 42 per cent during the 9-year period. The major reasons for posting continued to be related to the landowners' negative encounters with recreationists, especially hunters.

In 1980, Tuttle (1982) made a statewide survey to investigate the attitudes, interests, behavior and educational needs of private owners of rural lands concerning wildlife and habitat management on their properties. The data reported here are from that survey and are analyzed to measure changes in the incidence of land posting since 1972, as well as to make additional comparisons of posting and nonposting landowners for a better understanding of their posting behavior. The only legislative change after 1972 that related to recreational access to private lands was that the list of activities covered under Section 0-103 of the General Obligations Law (limiting landowner liability to recreationists) was expanded to include canoeing, snowmobiling, cross-country skiing, hang-gliding, speleological activities, boating, and cutting and gathering wood for noncommercial purposes.

PROCEDURE

The method used by Tuttle (1982) for sampling landowners followed that of Waldbauer (1966), making the data base compatible with those of that study and the one by Brown and Thompson (1976). The specific towns sampled were different, however, from those of the other two studies. The target audience was private, non-industrial owners of 10 or more acres of rural land in upstate New York. Rural land was defined as land in towns having a human population density of less than 150 people per square mile. The land area and population of incorporated villages were subtracted from town figures in calculating population densities. Upstate New York was defined as all of the State except the New York City Standard Metropolitan Statistical Area[3] (which included Rockland, Putnam and Westchester Counties from Region 3, as well as New York City and Long Island, Regions 2 and 1, respectively)[4]. Of the 941 upstate towns and cities, 768 were classified as rural by these definitions.

Towns served as the sampling units. A stratification process was used to ensure obtaining a sample that was representative of upstate New York. Strata were delineated according to several geographical characteristics, primarily the type and extent of agricultural land use and the extent of

[3]As defined by the U.S. Bureau of Census (1970).

[4]Throughout this paper, regions designated by number are the administrative regions of the State Department of Environmental Conservation.

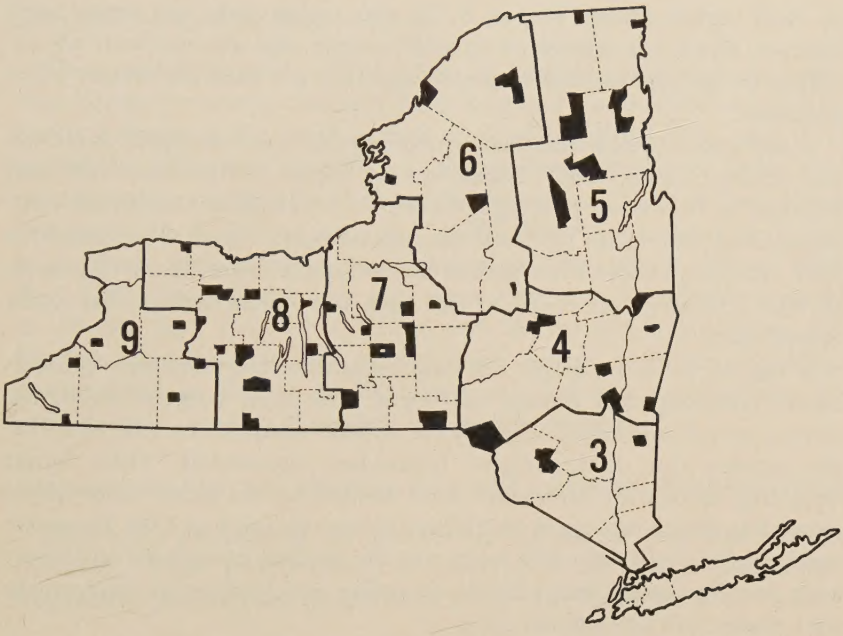

Figure 1. Administrative regions of the New York State Department of Environmental Conservation (except Regions 1 and 2 representing metropolitan New York and Long Island) and distribution of the towns in each (in black) that were selected for analysis of posting.

forest and urban areas. Fifty towns were selected randomly, having the distribution shown in Figure 1.

Within each town, 40 landowners were randomly chosen from all those eligible in the town by using county tax assessment listings. Only parcels of 10 acres or more with land-use classifications of residential, agricultural, forest or vacant lands were considered eligible. Commercial, industrial, recreation and entertainment, and community and public service lands were excluded.

The sampling procedure also differed from that used in the previous posting studies regarding within-town sampling rates. Brown and Thompson (1976) selected 25 per cent of the landowners with 10 or more acres in each town, regardless of the number eligible, whereas in the present study a standard sample of 40 was selected. The number of eligible owners in the 50 sample towns ranged from 50 to 630, with a mean of 239, resulting in sampling rates per town ranging from 6 to 80 per cent, with a mean of 17 per cent.

When the sample towns were grouped according to the administrative regions, the proportion of the eligible towns that were sampled ranged from 3.5 per cent for Region 6 to 8.9 per cent for Region 4 (Regions 1 and 2 were not included in the study area). From five to 11 towns were sampled

in each region except Region 3. In this region only two towns were selected, which was considered an undersample, and the results are not included in the regional analyses although they are used for certain other purposes.

A self-administered mail-back questionnaire was developed, pretested and revised (Tuttle, 1982). The survey was begun in November 1980 and followed a four-wave mailing procedure. A telephone survey of nonrespondents was made to check nonrespone bias. Three nonrespondents were randomly chosen from each of the 50 sample towns, and a minimum of four attempts were made to call each one unless contact was made before that.

It was necessary to weight the data because of the variability of landowner sampling rates among the towns. The total number of eligible owners in each town was divided by the number sampled (i.e., 40) to derive the number that each sampled landowner represented. These initial weighting factors for each town were divided by the mean value which resulted in final town-based weighting factors averaging to 1.00. However, weighting was used only with respect to the analyses of regional and statewide posting rates. Comparisons of posting and nonposting landowners were made with unweighted data.

FINDINGS AND ANALYSIS

From the initial mailing of 2,000 questionnaires, 72 were undeliverable by mail and 40 were returned by ineligible landowners (they no longer owned 10 or more acres of land in the sample town for which they had been chosen). The adjusted sample of 1,888 yielded 1,295 useable returns (68.5 per cent). Regional response rates are shown in Table 1.

Of 150 respondents chosen for the telephone follow-up, telephone numbers were undetermined or incorrect for 69, five were ineligible because they had sold their land, and five refused to participate. In the follow-up survey, 59 out of a possible 71 interviews were completed.

TABLE 1. RATE OF RESPONSE FROM LANDOWNERS TO QUESTIONNAIRE CONCERNING POSTING, ACCORDING TO REGION

Region	Number of codeable returns	Adjusted response rate* (per cent)
3	40	54.8
4	251	67.7
5	166	63.8
6	126	64.6
7	258	74.4
8	297	71.2
9	157	69.8
Total	1,295	68.6

*Represents: codeable returns ÷ [40 − (ineligible + undeliverable)].

NONRESPONDENTS VS. RESPONDENTS

The unweighted results of the follow-up telephone interviews with nonrespondents were compared with the unweighted results of the mail survey. Partly because of the small sample of nonrespondents (59), only three significant differences were found. Respondents were more likely than nonrespondents to have cut firewood on their property within the previous two years (65 vs. 51 per cent, $P < 0.05$). More respondents than nonrespondents were active in hunting during 1980 (46 vs. 34 per cent, $P < 0.10$). Respondents were also more active in winter birdfeeding (41 vs. 29 per cent, $P < 0.10$). There were no statistically significant differences concerning acreage of rural land owned; incidence of posting; participation in fishing, birdwatching or brush-pile construction; sex ratio; income; or ratio of resident to absentee owners.

INCIDENCE OF POSTING AND RELATION TO LANDOWNER RESIDENCE TYPE

Forty-eight per cent of the landowners had posted their land in 1980 (Table 2). These people owned 58 per cent of the land in the sample. Regionally, posting rates ranged from 28 per cent in Region 5 to 53 and 55

TABLE 2. PERCENTAGE OF LANDOWNERS WHO POSTED AND PERCENTAGE OF POSTING LANDOWNERS WHO ALLOWED HUNTERS ON THEIR LAND IF PERMISSION WAS REQUESTED, ACCORDING TO REGION

Region	Landowners who posted in 1980	Landowners who posted previously	Posting landowners allowing hunting with permission
4	53	57	55
5	28	37	42
6	51	51	53
7	47	62	74
8	55	67	78
9	43	52	74
Statewide*	48	57	65

*Data for Region 3 included in computing statewide figures.

TABLE 3. MEAN ACREAGE OF POSTING AND NONPOSTING LANDOWNERS, ACCORDING TO REGION

Region	Mean acreage		
	Posting landowners	Nonposting landowners	All landowners
4	109	65	88
5	123	92	101
6	196	104	150
7	133	111	124
8	130	86	109
9	77	83	81
Statewide*	122	87	105

*Data for Region 3 included in computing statewide figures.

TABLE 4. DISTRIBUTION (IN PER CENT) OF LANDOWNERS ACCORDING TO THE RELATIONSHIP OF THEIR RESIDENCE TO THE LOCATION OF THEIR PROPERTY, BY REGION, IN 1972 AND 1980*

	Owners resident in same county as property		Absentee owners			
			Metropolitan§		Non-metropolitan	
Region	1972	1980	1972	1980	1972	1980
4	61	63	27	34	12	3
5	61	60	20	31	18	9
6	78	74	7	22	15	4
7	83	81	9	14	7	6
8	87	77	9	20	4	3
9	89	68	4	26	7	6
Statewide†	69	71	20	25	9	4

*Data for 1972 from Brown and Thompson (1976).

§Residents in a county that was part of a Standard Metropolitan Statistical Area. More New York counties were in such areas in 1980 than in 1972.

†Data for Region 3 included in computing statewide figures.

TABLE 5. PERCENTAGE OF RESIDENT AND ABSENTEE LANDOWNERS WHO POSTED IN 1972 AND 1980, ACCORDING TO REGION*

	Owners resident in same county as property		Absentee owners					
			Metropolitan§		Non-metropolitan		Total	
Region	1972	1980	1972	1980	1972	1980	1972	1980
4	42	48	66	64	48	49	58	62
5	24	26	32	35	23	20	28	32
6	29	47	29	59	7	55	14	59
7	33	53	36	31	9	31	24	31
8	52	62	43	45	17	58	35	47
9	39	41	50	46	25	53	33	47
Statewide†	41	50	50	50	33	40	43	48

*Data for 1972 from Brown and Thompson (1976).

§Residents in a county that was part of a Standard Metropolitan Statistical Area.

†Data for Region 3 included in computing statewide figures.

TABLE 6. REGIONAL DISTRIBUTION (IN PER CENT) OF LANDOWNERS ACCORDING TO RESIDENCE AND USE OF PROPERTY

	Resident on property			Absentee		
				Days spent on property per year		
Region	Farm	Nonfarm	Total*	0-100	101 +	Total*
4	8	47	54	36	9	46
5	9	39	48	45	7	52
6	14	34	48	47	5	52
7	19	50	69	29	2	31
8	13	45	58	37	5	42
9	9	46	55	37	8	45
Statewide§	12	45	57	38	6	43

*Some totals are not equal to sum of the two components because of rounding.

§Data for Region 3 included in computing statewide figures.

per cent in Regions 4 and 8, respectively. However, 57 per cent had posted their land sometime in the past, indicating that some landowners had discontinued the practice. The only exception was Region 6 where the posting rates in 1980 and previous years were equal.

In every region except Region 9, posting landowners had larger landholdings on the average than nonposting landowners (Table 3). The ratio of the mean acreage of posting landowners to that of nonposting landowners was greatest for Regions 4 and 6 (1.7 : 1 and 1.9 : 1, respectively) and lowest for Region 9 (0.9 : 1).

Although in both the 1972 and 1980 studies 29 per cent of the landowners were absentees, the proportion of absentees whose principal residence was in a metropolitan area had increased (Table 4). There were large differnces between 1972 and 1980 in the resident-to-absentee ratio only in Regions 8 and 9 where the proportions of absentee owners were greater in 1980.

As in 1972, no significant differences were found between the posting rates of resident and absentee owners (Table 5). Absolute increases in the rates for the two groups were 9 and 5 per cent, respectively. The increase for the absentee owners was attributable to those living in non-metroplitan areas; absentees residing in metropolitan areas showed no change between 1972 and 1980.

To determine whether posting rates were affected by landowners' use of their rural properties, the data were analyzed according to several residence categories. Respondents living on their property were subdivided into farm and nonfarm residents. Absentee owners (those not living on their property the year around) were divided into two groups based on the average number of days per year they spent there over the previous few years, i.e., 100 days or less and more than 100 days. The regional composition of these four landowner groups is shown in Table 6.

By the strictest definition, 43 per cent of all the landowners surveyed would be classified as absentee owners (not living on the sample property). But if the definition of resident is broadened to include all landowners who resided in the same county as the land in question (as used by Brown et al., 1977 and Brown and Thompson, 1976) the proportion of absentee owners was 28 per cent. Because no information was directly obtained concerning the location of the legal domicile of the absentee owners, it was assumed that tax bill addresses were the equivalent for purposes of classifying landowners as residents or nonresidents of the county. Given this assumption, the 28 per cent estimate for absentees corresponded to the 28 per cent figure found by Brown et al. (1977) in a study of rural landowners in five central New York counties and to the 29 per cent figure found by Brown and Thompson (1976) in the previous posting study.

Regions 7, 6 and 8 had the highest porportions of farm residents (19, 14 and 13 per cent, respectively). Regions 5 and 6 had the largest proprotions

TABLE 7. PERCENTAGE OF LANDOWNERS IN EACH REGION WHO POSTED, ACCORDING TO RESIDENCE AND USE OF PROPERTY

	Resident on property			Absentee		
				Days spent on property per year		
Region	Farm	Nonfarm	Total	0-100	101 +	Total*
4	54	49	50	52	84	58
5	47	23	28	26	54	29
6	46	37	40	69	34	65
7	50	57	55	34	59	35
8	68	59	61	52	68	54
9	4	50	42	43	53	45
Statewide*	49	51	51	46	68	49

*Data for Region 3 included in computing statewide figures.

of owners not residing on their property (52 per cent each). Residents were proprotionately most numerous in Region 7 (69 per cent).

Over-all, resident and absentee landowners did not post at sigificantly different rates, nor did farm and nonfarm residents (Table 7). However, over two-thirds of the absentee owners who visited their property more than 100 days per year posted their lands compared with fewer than half of those whose visits were less frequent.

Regionally, there was statistical variability in the posting rates of residents and absentees. Residents posted more frequently than absentees in two regions (7 and 8) and less frequently in two regions (4 and 6), while in two regions (5 and 9) the rates for the two groups were similar. The differences were statistically significant when tested by chi square ($P < 0.05$) in only two regions: 65 per cent of the absentees compared with 40 per cent of the residents posted in Region 6, while 35 per cent of the absentees and 55 per cent of the residents posted in Region 7. In five of the six regions, the high-visitation absentee owners posted more frequently than the other landowner groups, while the low-visitation absentees ranked third or fourth.

HUNTING ON POSTED LAND

Approximately two-thirds of posting landowners allowed hunting on their property if permission was requested (Table 8). The posting landowners in Regions 7 and 8 were the most permissive (in both regions 78 per cent allowed hunting access), whereas those in Region 5 were least likely to allow hunting (42 per cent). Farm residents were the most likely to allow hunters on their properties and high-visitation absentees were the least likely. Statewide, 86 per cent of farm residents, 67 per cent of nonfarm residents, 61 per of low-visitation absentees and 37 per cent of high-visitation absentees allowed hunting if asked. In every region, farm residents who posted were more likely to allow hunting than nonfarm residents who posted. In every region for which estimates could be made,

Table 8. Percentage of Posting Landowners Who Allowed Hunting If Permission Was Requested, According to Residence and Use of Property

Region	Resident on property		Absentee				All landowners
			Days spent on property per year		Residence		
	Farm	Nonfarm	0-100	101 +	Metropolitan*	Nonmetropolitan	
4	82	70	41	33	31	33	56
5	61	46	43	†	38	36	42
6	57	42	63	50	64	†	56
7	92	70	82	62	73	100	78
8	97	74	78	57	78	72	78
9	99	78	74	49	63	45	73
Statewide§	86	67	61	37	60	58	65

*Residents in a county that was part of a Standard Metropolitan Statistical Area.

§Data for Region 3 included in computing statewide figures.

†Too few data for valid estimate.

posting low-visitation absentees were more permissive of hunting than high-visitation absentees. Metropolitan and non-metropolitan absentees posted at similar rates.

Differences in wording and response categories on the questionnaires in 1972 and 1980 prevented direct comparison between the two surveys concerning the trend in hunting-access-granting behavior toward people of various acquaintanceship types. In 1972, 79 per cent of posting landowners allowed some hunting, while in 1980, 65 per cent indicated that they allowed hunting if permission was requested. However, a category was provided in the 1972 study for landowners who allowed hunting by friends and neighbors only; this could account for the larger estimate in 1972.

Posting Trends

The incidence of posting in New York continued to increase after 1972. In the 1963 study Waldbauer (1966) estimated that 26 per cent of private owners posted, while in 1972 Brown and Thompson (1976) found that 42 per cent of landowners posted their land (these people owned 48 per cent of the land in the sample). In the present study, 48 per cent of the respondents posted their land in 1980—a 14 per cent increase over the 1972 level. The 48 per cent who posted owned 58 per cent of the land in the sample. Data were not collected on the acreage of properties posted in 1980, but, assuming that the proportion was the same as that in the previous study (i.e., 86 per cent), 50 per cent of all private acreage would have been posted. Thus, the incidence of private land posting increased from 26 per cent in 1963 to 42 per cent in 1972 and, further, to approximately 50 per cent in 1980 (Figure 2).

Regional posting rates (percentage of landowners posting) for 1972 and 1980 are shown in Table 9. In Regions 6 and 7 there were dramatic increases in posting over the 8-year period. In Region 6 where the increase was 96 per cent the rate in 1980 was close to the statewide average, whereas

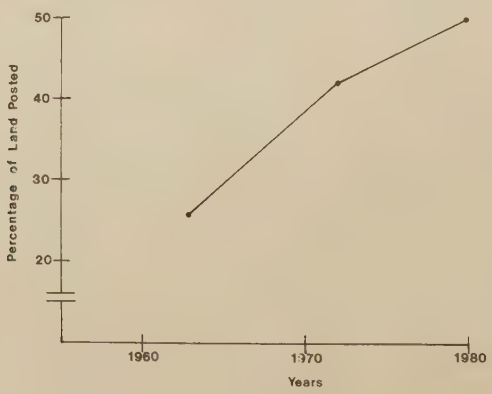

Figure 2. Trend in the posting of private rural land in New York (1963-1980).

TABLE 9. CHANGE IN THE PERCENTAGE OF LANDOWNERS WHO POSTED IN 1980 COMPARED WITH 1972, ACCORDING TO REGION*

Region	Posting landowners		Change	
	1972	1980	Absolute	Proportional§
4	49	53	+ 4	8
5	27	28	+ 1	4
6	26	51	+25	96
7	31	47	+16	52
8	51	55	+ 4	8
9	38	43	+ 5	13
Statewide†	42	48	+ 6	14

*Data for 1972 from Brown and Thompson (1976).

§Represents: absolute change ÷ 1972 value × 100.

†Data for Region 3 included in computing statewide figures.

that in 1972 had been the lowest regional figure, considerably below the average. That a higher posting rate existed in this region in 1980 was attested by the finding that it was the only region where the percentage of landowners who had ever posted before equaled the percentage currently posting (Table 2). Some regional patterns in the incidence of posting in 1980 were similar to those in 1972. Region 5 continued to have a low incidence, while Regions 4 and 8 were still the most heavily posted regions (excluding Region 3) in the State. However, much less variation in posting rates existed in 1980 than in 1972.

FUTURE POSTING PLANS

The percentage of rural landowners (with 10 or more acres) who posted their land continuously increased since the first comprehensive survey in 1963. To estimate whether or not this trend would continue, landowners were asked about plans for posting their lands over the next two years (i.e., 1981 and 1982). An answer choice of "maybe" was permitted to preclude forcing undecided owners into a definite affirmative or negative answer. Thus, using "yes" responses as an estimate of the rate in 1982, the data indicated that posting could be expected to increase by about 3 per cent from 1980 to 1982 (Table 10). Over one-fifth of the landowners (45 per cent of those who did not post in 1980) were possible candidates for posting in the future as evidenced by their response of "maybe".

There was considerable variation among the regions in the absolute change in posting rates projected by the landowners for the 1981-1982 period. The largest increases, about 5 per cent, were in Regions 5 and 7 (Table 11). A fairly constant rate was anticipated in Regions 6, 8 and 9, and a moderate increase in Region 4. Over-all, posting rates were expected to increase more among nonfarm residents and low-visitation absentee owners (together representing 82 per cent of all respondents) than among farm residents and high-visitation absentees.

Table 10. Future Plans to Post Based on Expressed Intentions of Landowners in 1980, According to Region*

Region	Posted in 1980	Plan to post in next two years		Change§
		Yes	Maybe	
4	53	55	19	2
5	28	32	27	4
6	51	51	20	0
7	47	52	21	5
8	55	56	25	1
9	43	43	23	0
Statewide†	48	51	22	3

*Figures in per cent.

§From 1980 to 1982, based on "yes" responses only for future plans.

†Data for Region 3 included in computing statewide figures.

Comparison of Posting and Nonposting Landowners

Except that posting landowners generally held larger acreages than nonposting landowners (Table 3), no other significant difference in the property characteristics of the two groups was found. The proportions of acreage in managed open land, homestead, brushland, woodland and wetland did not differ significantly between the groups. The mean duration of land tenure was 19 years in both cases. These findings corresponded to those of Brown and Thompson (1976).

Levels of education and income were not significantly related to posting rates, nor was the mean age of landowners (52.3 vs. 53.3 years for posting vs. nonposting owners). Landowners less than 40 years old posted at a greater rate than older owners (54 vs. 47 per cent, $P < 0.01$). Landowners under 30 years old (47) posted at the highest rate (60 per cent) of any age group.

With respect to occupation, the service worker-laborer group had the lowest incidence of posting (39 per cent), while craftsmen, foremen and operatives had the highest (54 per cent). Fifty per cent of the farmers, compared with 46 per cent of those engaged in professional, technical and managerial occupations, posted their lands.

Participation in Wildlife-related Recreational Activities

Participation in five of the six wildlife-related recreational activities considered was significantly higher for posting than non-posting landowners (Table 12), the exception being fishing. In the 1972 study, which examined a broader list of activities, participation by posting landowners was significantly greater than that by nonposting owners for only three activities, i.e., deer hunting (49 vs. 45 per cent), nature study (39 vs. 35 per cent) and hiking (40 vs. 32 per cent) as reported by Brown and Thompson (1976). With respect to deer-hunting landowners, the degree to which

Table 11. Percentage of Landowners, According to Residence and Use of Property, Who Planned to Post in the Next Two Years, By Region

Region	Resident				Absentee (days spent on property per year)				Total	
	Farm*		Nonfarm		0-100		101+			
	Yes	Change§	Yes	Change§	Yes	Change§	Yes	Change§	Yes	Change§
4	49	− 5	52	3	57	5	81	4	55	2
5	43	− 4	30	7	30	5	67	13	32	4
6	50	4	47	10	58	−10	54	20	51	0
7	47	− 3	64	7	39	5	60	1	52	5
8	73	5	54	− 5	54	2	66	− 2	56	1
9	22	19	47	− 3	42	− 1	53	0	43	0
Statewide†	50	1	53	2	48	2	69	1	51	3

*Main residence on property surveyed.

§Percentage who planned to post in future minus percentage who posted in 1980; values represent increase unless otherwise noted.

†Data for Region 3 included in computing statewide figures.

Table 12. Percentage of Posting and Nonposting Landowners Who Participated in Wildlife-related Recreational Activities in 1980

Activity	Posting landowners (615)	Nonposting landowners (669)
Hunting**	56	38
Freshwater fishing	37	35
Trapping*	10	5
Nature study/walks*	60	53
Birdwatching*	44	37
Wildlife art/photography**	19	12

*Difference significant at $P < 0.05$.

**Difference significant at $P < 0.01$.

those who posted exceeded those who did not increased from 4 per cent in 1972 to 18 per cent in 1980. While only a small percentage of landowners trapped, a similar trend was evident; the differential between those who posted and those who did not increased from 7 vs. 8 per cent in 1972 to 10 vs. 5 per cent in 1980.

Expressed another way, for all activities except fishing, the proportion who posted was significantly higher among participating than nonparticipating landowners. These differences were not large for birdwatchers (52 per cent posted vs. 48 per cent did not post) and those who enjoyed nature walks (51 vs. 49 per cent). However, among hunters, 58 per cent posted while 42 per cent did not. For trappers, the comparison was 62 vs. 38 per cent, and for wildlife photographers it was 59 vs. 41 per cent.

As the number of recreational activities in which landowners participated increased, the incidence of posting increased. Specifically, while only 32 per cent of those who were active in none of the six activities posted their lands, the proportion increased to 42 per cent of those who participated in one activity, to 53 per cent of those involved in two, three or four activities and to 67 per cent of those active in five or six.

Participation in Wildlife Habitat Improvement

Landowners were asked to check the wildlife habitat improvement activities (from a list of 13) that they had engaged in on their lands within two years of when they received the questionnaire. For every practice considered, a greater percentage of posting than nonposting landowners had applied it on their rural land. The mean number of wildlife practices employed was 2.7 for posting landowners and 1.8 for nonposting landowners (a significant difference at $P < 0.0001$).

To facilitate further analysis, landowners were divided into four activity-level groups[5] based on the number of practices they had used within the

[5]The groups were: nonparticipants (0 activities), low level (1-3 activities), medium level (4-5 activities) and high level (6 + activities). They comprised 27, 47, 17 and 9 per cent, respectively, of the landowners.

two years preceding the survey. As the activity level increased, the proportion of landowners posting increased. Specifically, 36 per cent of the nonparticipants, 47 per cent of the low-level, 59 per cent of the medium-level and 74 per cent of the high-level groups posted in 1980.

Landowners who had done some wildlife habitat improvement were asked to rank their top two reasons (from a list of six) for helping wildlife. Those who ranked "to create better opportunities for hunting" as either first or second posted a much higher rate (70 per cent) than the average for the group as a whole (53 per cent). Landowners choosing the reason "to create better opportunities for observing wildlife" posted at a lower-than-average rate (45 per cent). Landowners undertaking wildlife work because they "enjoy working on the land so wildlife work gave me a good purpose" also posted at a higher-than-average rate (59 per cent). Posting rates with respect to the other three reasons (felt a personal obligation, to gain satisfaction of accomplishing something, and believed healthier wildlife populations mean a beter environment for man) did not differ significantly from the average.

One additional finding supports the conclusion that those landowners who were more favorably inclined toward wildlife also had a greater tendency to post. Posting landowners were more likely than nonposting owners to profess habitat improvement as the proper role of the landowner regarding wildlife (41 vs. 26 per cent) and less likely to take the neutral role of not managing for wildlife at all (54 vs. 69 per cent). Five per cent of both posting and nonposting groups considered their appropriate role to be controlling damage by wildlife. Of those choosing habitat improvement 59 per cent posted, while of those who professed a neutral role only 42 per cent posted.

PARTICIPATION IN FORESTRY ACTIVITIES

Landowners were asked to indicate which of a list of 10 forestry practices they had employed on their land in the two years prior to the survey. As with wildlife habitat management, posting landowners were significantly more active than nonposting landowners in the management and use of their forest lands. This applied to every practice except cutting pulpwood and planting trees for a timber plantation. As the number of practices undertaken increased, the incidence of posting increased: 30 per cent for landowners who reported no forestry activity compared with 51 per cent for those who employed one or two practices and 60 per cent for those using three or more.

LAND USE AND WILDLIFE-RELATED ATTITUDES

Landowners were asked to express whether they agreed or disagreed with a series of statements dealing with land use, wildlife-forestry conflicts,

and various topics concerning wildlife use. There were no significant differences between posting and nonposting landowners in the general ratios of agreement to disagreement for all 10 statements. The only difference noted was that posting landowners tended to express strong agreement or disagreement more often than nonposting landowners, suggesting that they may hold stronger opinions about natural resource topics.

Awareness of Conservation Agencies and Programs

Posting and nonposting landowners were similar in their levels of awareness of the offerings of various government agencies (e.g., N.Y.S. Department of Environmantal Conservation, Cooperative Extension and U.S.D.A. Soil Conservation Service) and cooperative programs for landowners (e.g., New York's Forest Practice Act and Fish and Wildlife Management Act). The only significant difference ($P < 0.05$) was in regard to the U.S.D.A. Agricultural Stabilization and Conservation Service; 37 per cent of the posting landowners, compared with 29 per cent of the nonposting landowners, believed they were well aware of this agency's offerings to landowners. Expressed another way, of those well aware of the agency, 55 per cent posted their land. The high percentage of posting landowners among this group is more attributable to the group's involvement in wildlife-related activities than its relationship to farming; only 50 per cent of farmers posted their lands.

DISCUSSION

In addition to updating estimates of the incidence of posting statewide and regionally, the 1980 study constitutes a major contribution toward understanding the degree to which frequent use of a landowner's property for wildlife-related purposes is associated with posting. This is particularly true for the landowners (43 per cent) studied who did not live on their rural land. For these absentee owners (some of whom lived near their rural property), the distinguishing factors in their incidence of posting were how often they used their property for wildlife-related activities and whether or not they lived in metropolitan areas of New York or other states.

The data indicating the trend in the incidence of posting from 1972 to 1980 are straightforward, but it must be recognized that the 1972 and 1980 studies had different foci. The 1972 study examined landowner attitudes toward recreationists based on encounters the landowner, a neighbor or others had had with recreationists. Although negative experiences with and negatively perceived reputations of hunters and snowmobilers contributed to the increase in the posting level from 1963 to 1972, the use of the landowner's property for wildlife-related purposes received very little attention in the 1972 survey. On the other hand, the 1980 survey was undertaken primarily to determine the interests of rural landowners in wildlife-related activities, and the posting analysis was a by-product. As a

result, the 1980 survey had little material on the attitudes and perceptions of landowners toward recreational activities or recreationists, or on related encounters that were influential in landowners' decisions to post their properties. Any future posting study should give adequate attention to both the wildlife interests of landowners and their experiences with recreationists.

The 1972 study showed that the rate of increase in posting from 1963 to 1972 was sufficiently high that, if it continued, all private acreage would be posted by 1993. Although more acreage was posted in 1980 than in 1972, the average annual increase in the rate of posting had declined by more than 50 per cent. The proportion of posting landowners increased annually by an average of 1.9 per cent from 1963 to 1972, compared with about 0.75 per cent for 1972 to 1980.

The causes of the slowed increase in the posting rate are not known, but the following factors were undoubtedly influential.

1. The growth in the population and its affluence during the 1960's did not continue in the 1970's. New York's population, which grew from 16.8 million in 1960 to 18.2 million in 1970, declined by 3.3 per cent to 17.6 million in 1980. Similarly, median family income nationally, expressed in 1980 constant dollars, increased by about one-third, from $15,637 in 1960 to $20,939 in 1970. This figure increased another 4.5 per cent to $21,895 in 1972, the year of the previous posting study, and it remained relatively constant for the rest of the decade, although it fell to $21,023 in 1980. Thus, the population was slightly larger in 1972 than in 1980, and it was slightly more affluent, particularly when one considers that the price of gasoline tripled in the interim. As a result, landowners may not have felt as much pressure from recreationists in 1980 as in 1972. Certainly the greater pressure over the period of 1970 to 1980 was a more recent phenomenon in 1972, and consequently it was probably more visible and thus led to a higher annual increase in the posting rate.
2. Although landowners posting in 1972 indicated that hunters were the recreationist group leading them to post, these landowners seemed equally concerned about snowmobilers. Snowmobile registrations peaked in New York in 1972, with approximately 155,000 registered vehicles. The number declined steadily through the remainder of the decade, resulting in a 44 per cent drop to 85,639 registered vehicles in 1981. This large decline in snowmobiling was somewhat counterbalanced, however, by increases in hunting. Sales of resident big game licenses, for example, increased by 27 per cent, from 527,000 in 1972-73 to 671,000 in 1981-82.
3. The 1972 posting study heightened the awareness of both the State Department of Environmental Conservation staff and other conservation organizations in the State to the fact that the posting of private

lands, if continued at the 1963-1972 rate, could endanger the future of hunting in New York. Following that study, multidimensional approaches were undertaken to reach hunters to increase the degree to which they requested permission to use private lands and to increase the respect shown toward private landowners and their properties. Several pilot efforts were also initiated at the regional level to have sportsmen work with landowners in an attempt to improve relations between these groups. While the direct impact of these measures is difficult to evaluate, they undoubtedly have had some success.

4. Concurrent with the activities described in (3), a major effort has been pursued by the Cooperative Extension organization, often in conjunction with the State Department of Environmental Conservation, to clarify landowner liability as it relates to recreationists using private property. Printed materials and workshops covering this topic have reached thousands of rural landowners. New York now offers the landowner about as much protection from liability to recreationists as is feasible, and communicating this information to landowners has likely been one factor leading to a reduction in the annual rate of new posting.

Regardless of the legality of hunting on private, unposted land without permission, it is clear that the vast majority of both posting and nonposting landowners expect hunters to request permission before they enter private lands to hunt. This should continually be stressed in materials produced for sportsmen. In many respects, posting landowners should be perceived by sportsmen not as barriers to hunting, but rather as responsible citizens who are exercising their legal right to know when others are using their property and to control that use. The 1980 study indicates that many of those who post have direct involvement with wildlife (the majority are involved in both hunting and nonconsumptive wildlife activities). The majority also allow hunting if permission is requested.

From the preceding information, several areas emerge for continued work and investigation in the 1980's. Simultaneous pursuit of these, given some measure of success, should help maintain a sufficient supply of private land open to hunting throughout the State.

1. Educational work with recreationists on the importance of respecting private property and obtaining landowners' permission to use it.
2. Efforts through education to convert the image of the posting landowner from that of one who is uncooperative and dislikes hunters to one who likely engages in wildlife activities and will probably allow hunting if permission is asked.
3. Exploration of ways of identifying for hunters those landowners who will allow hunting. Such efforts should involve landowners who do not post, as well as those who do. Data presented here identify the regions (e.g., Region 4 and 5) as well as the audience (e.g., high-

visitation absentee landowners and nonfarm resident owners) that could become key targets for programs to reduce rural land posting. Furthermore, methods should be developed to facilitate hunters gaining communications access to low-visitation absentee landowners, who are the more permissive toward hunting access.

4. Determination of the factors that influenced previously posting landowners to cease posting. This might provide some valuable clues to approaches for continued deceleration of posting.

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ATLANTIC STURGEON OF THE HUDSON ESTUARY, NEW YORK[1]

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ABSTRACT

The biological characteristics of the Atlantic sturgeon of the Hudson Estuary were studied by analyzing data, including age and weight records for tagged and recaptured fish. Migration patterns and behavior of spawning adults were monitored by sonic transmitters attached to live-trapped and released individuals. The findings are presented and discussed in relation to the status of this population and the environmental factors affecting it. Regulations with resepct to taking Atlantic sturgeons that would constitute good management in these waters are outlined.

When the early Dutch settlers reached the shores of the Hudson Estuary,[3] the Indians living there were observed to feed on sturgeons which, like other fishes, were plentiful and easy to catch (Mitchill, 1811; Van der Donck, 1841). From that time until the present day sturgeons have been present in the Hudson. However, their numbers there and in other Atlantic Coastal estuaries had declined appreciably by 1900 due to an increase in the harvest of these fish for food following the Civil War (Murawski and Pacheco, 1977). Evidence suggests that the population level has remained fairly stable in the Hudson during the past 60 to 70 years and that, while overexploitation was generally credited with causing the initial decline in abundance, other factors have contributed to the perpetuation of the stock at a low level. The present project was undertaken to help clear up some of the confusion in the literature regarding the Atlantic sturgeon (*Acipenser oxyrhynchus*) that has resulted from applying regional, often fragmentary, data on its biological characteristics to the species in general. Such application is particularly confusing where a species such as the sturgeon exhibits substantial variation in morphology and apparently also exhibits variations of anadromous characteristics.

AREA OF INVESTIGATION

The Hudson River and Estuary extend 504 kilometers from Lake Tear-of-the-Clouds in the Adirondack Mountains to the Atlantic Ocean. In

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[1]This investigation was funded jointly by the New York State Department of Environmental Conservation and Boyce Thompson Institute for Plant Research, Yonkers, N.Y. The concept of the project originated with R. H. Boyle of Sports Illustrated.

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[3]In keeping with the "semi-enclosed" nature of estuaries as described by Pritchard (1967), the senior author chooses to use the term "estuary" to denote the Hudson River below the dam at Troy, N.Y.

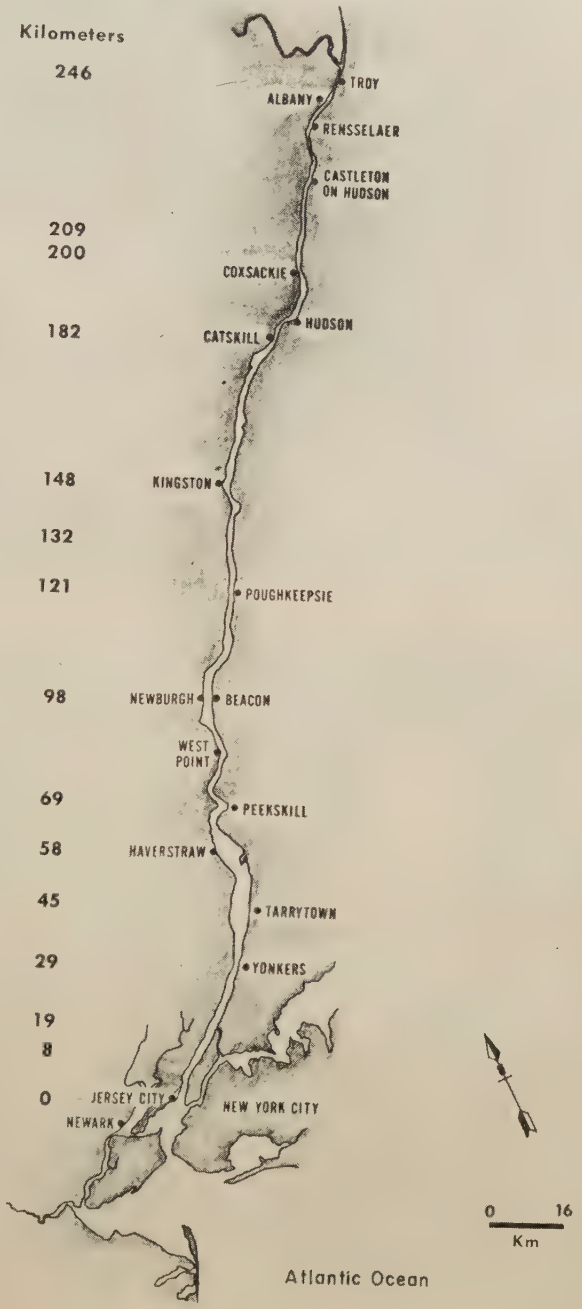

Figure 1. The Hudson Estuary from its mouth to Albany.

1826 a dam and navigable lock were constructed at Troy (N.Y.) just south of its confluence with the Mohawk River. This investigation was conducted over the 246-kilometer part of the river below Troy, i.e., the Hudson Estuary (Figure 1).

The estuary is tidal and usually contains salt water upstream to about Newburgh (kilometer 98) during dry seasons but only as far north as Yonkers (kilometer 29) during wet seasons. The Hudson Estuary may be classified as a type-A, coastal plain estuary (Pritchard, 1967), having several deep areas that give the system some characteristics resembling a fjord. Much of the bottom is composed of silt, sand and clay and is periodically dredged to a depth of about 11.8 meters to maintain a navigational channel to Albany-Troy (kilometer 233-246). Several bottom areas of the upper estuary are characterized by rock, primarily shale, slate and granite (Johnsen, 1966). Most of the estuary in this section is less than 1.6 kilometers wide. However, portions of the Tappan Zee and Haverstraw Bay are 4.5 to 6.0 kilometers wide with appreciable shallow, sandy areas 3.0 to 4.5 meters deep and some areas 4.5 to 10.7 meters deep adjacent to the channel. Marsh areas bordering the Hudson cover a space equal to about 2.0 per cent of the surface area of the river and contribute detritus to the estuary (D. Sirois, Boyce Thompson Institute, personal communication, 1975). The influence of the tide reaches to the dam at Troy where its amplitude is 1.46 meters compared with 1.34 meters at the Battery in New York Harbor (Panuzio, 1966). The Hudson, although simple in configuration with few tributaries, is hydraulically more complex than Chesapeake Bay (T. Hill, U.S. Corps of Engineers, personal communication, 1971).

MATERIALS AND METHODS

Data were obtained chiefly by tagging life-trapped fish and releasing them for subsequent recapture.

Field Methods

Juvenile Atlantic sturgeons were collected primarily in a semi-balloon otter trawl with a 35-foot headrope and gill nets of 10.2 and 15.2 centimeters in stretch mesh. Some trawls were equipped with 6.5-millimeter fine-mesh liners to collect larval and young sturgeons. The wings of the trawl were of 3.8-centimeter mesh with intermediate mesh of 2.5 centimeters. Otter boards, 0.6 × 1.5 meters, were attached to the trawls at the end of 10-foot leads to increase the area sampled as described by Bagenal (1964). Trawls were towed for durations ranging from a few minutes to over an hour, depending on the contour of the bottom and the direction of the tidal current. Selective sampling of the river was necessary due to obstacles encountered at most locations where trawling was attempted. Adult Atlantic sturgeons were taken in commercial gill nets with stretch mesh of 0.15 to 1.30 meters.

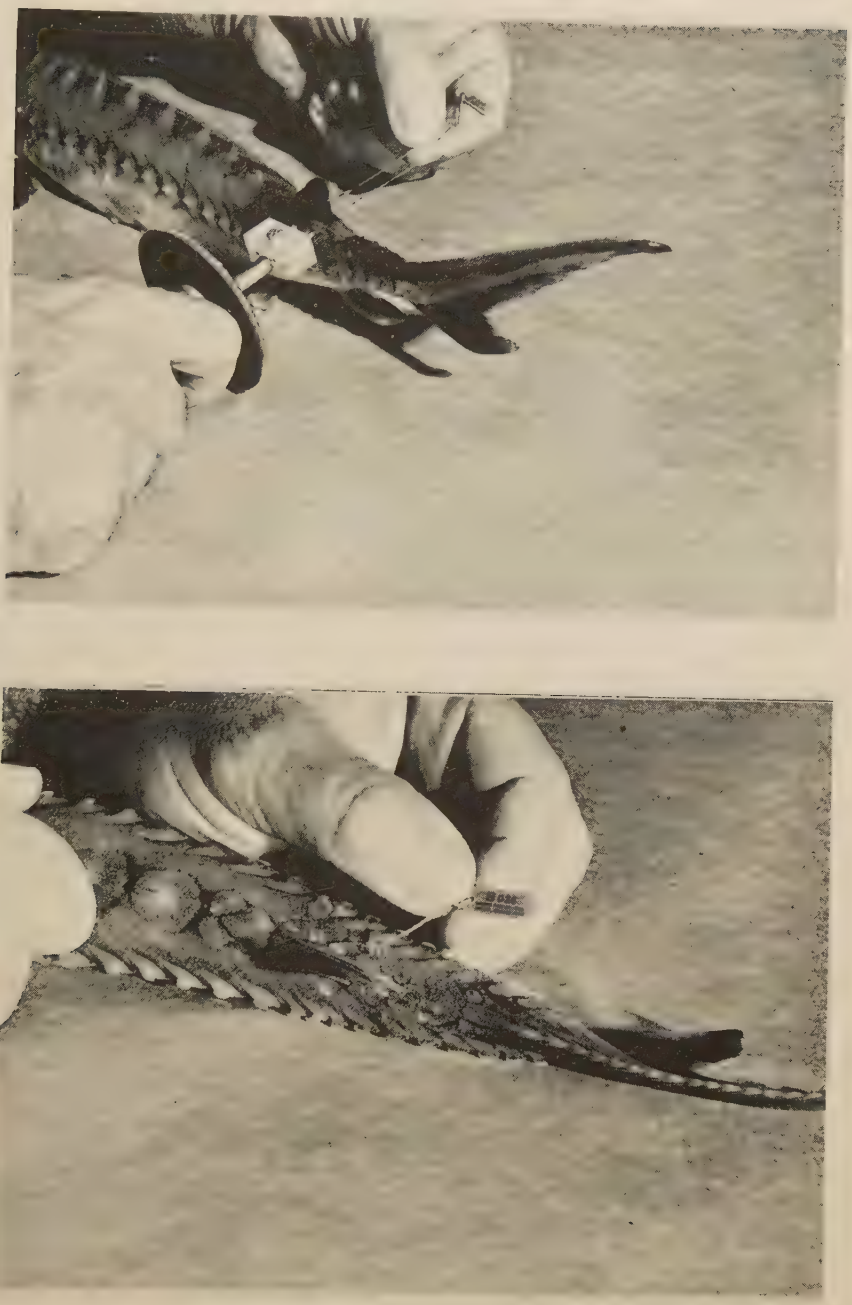

Figure 2. Application of Carlin-Ritchie disc dangler tag to an Atlantic sturgeon: (top) use of twin No. 18 hypodermic needles: (bottom) tag attached by twisted, flexible linkage to allow for growth.

The migration patterns of spawning adults were monitored by sonic transmitters (Bayshore Electronics) encased in pliable latex and attached by a soft wire to a bony plate forward of the dorsal fin. Each transmitter was fastened to a single plate by two wires passed through holes in the bone and twisted together.

Juvenile and adult fish were marked with Carlin-Ritchie disc dangler tags attached under the forward portion of the dorsal fin using twin No. 18 or 17-G hypodermic needles as shown in Figure 2. Length and weight information was obtained for each individual when possible.

Laboratory Methods

Bone sections for determining the ages of sturgeons were prepared by two methods, both modifications of the technique used by Cuerrier (1951). The first pectoral fin ray, and occasionally the second and third, were taken from live fish and dried for several weeks to several months prior to preparation. The rays were surgically removed immediately above the basal joint, and the wounds were observed to heal properly in less than a year.

Large rays (more than 1.0 centimeter in diameter) were embedded, with a strip of paper carrying specimen data, in hard Epon mounting fixative poured into a stoppered section of plastic tubing to form a cylinder from which transverse sections (0.2 to 0.4 milllimeter thick) were cut with a coping saw. Because these rough-cut sections of large bone required polishing, the embedded rays were placed in a vise and the first cut was made close to the base of the ray which usually exposed it in the shape of a letter "A". The end of the ray was filed smooth, and a second cut was made about 1 millimeter behind the polished end. The resulting section was glued, polished side down, to a glass slide with 5-minute clear Epoxy. The rough-sawed upper face of the ray was then smoothed by filing or by scraping a No. 15 Bard-Parker scalpel blade backwards over the bone.

Small rays, embedded in the same way, were sectioned with an American-Edsel miniature lathe with a circular saw blade 7.6 centimeters in diameter and 0.02 centimeter thick. Sections cut by the lathe did not require polishing.

Age was determined by examination under low-power magnification (less than 70X) of rays immersed in xylene and illuminated by transmitted light. Determinations of age were no problem for juvenile fish less than about 15 years old, once false annuli were recognized. Determinations for older fish were extremely difficult and may not justify the effort due to the low annual increments of growth, mineral reabsorption, the presence of false annuli and other undetermined growth characteristics.

Analytical Methods

The method of analyzing the tag-recapture data for population esti-

mates of juvenile Atlantic sturgeons relied heavily on the distributional behavior of the population: periods of low mobility and concentration in the lower Estuary followed by periods of greater mobility and intermixing within the population throughout the river. The population was concentrated in the vicinity of Haverstraw Bay during the period from late fall through late spring when large numbers of sturgeons could be collected for a given amount of effort. However, truly random sampling could not be accomplished due to the limited areas in which the bottom trawl or commercial gill nets could be used.

SAMPLING DESIGN FOR POPULATION ESTIMATION Since the dispersal of sturgeons was low at this time, the sampling design was based on the assumption that newly tagged individuals have a higher probability than unmarked individuals of being caught in samples taken soon after tagging. Approximately 90 per cent of the fish tagged during the October-December period and the March-June period were recaptured during the same period (or within a few weeks between periods), having moved less than 3 miles from the initial collection site. Therefore, the sampling design had to allow enough time for the tagged fish to intermix with the unmarked segment of the population and thus effectively randomize themselves with respect to marked status.

This randomization occurred during the summer months (July-September) when the population was dispersed over a wider range of the Estuary (upstream as far as Kingston, kilometer 148). Two sturgeons recaptured in August 1977 had moved 29 and 90 kilometers upstream from the initial collection site. An individual tagged in the Kingston area during mid-September moved 88 kilometers downstream by mid-October 1977. This pattern of upstream and downstream movement beginning in late spring and extending into the fall ensured adequate mixing with respect to mark status. As a result, the 2½ years of data were partitioned into eight sampling periods as shown in Table 1.

The problem of assessing the recruitment of younger fish into the catchable segment of the population was lessened by partitioning the catch into

TABLE 1. LENGTH CRITERIA USED TO DEFINE VARIOUS YEAR CLASSES OF JUVENILE ATLANTIC STURGEONS, ACCORDING TO PERIOD OF COLLECTION

Period	Date	Length (in centimeters) according to year class*			
		1975 and over	1976	1977	1978
1-2	Mar. 30 - Sept. 30, 1976	all	. .	. .	. .
3	Oct. 1 - Dec. 31, 1976	over 36	36 or less	. .	. .
4	Mar. 4 - June 30, 1977	over 38	38 or less	. .	. .
5	July 1 - Sept. 30, 1977	over 50	37 - 50	36 or less	. .
6	Oct. 1 - Dec. 31, 1977	over 54	39 - 54	38 or less	. .
7	Mar. 28 - June 30, 1978	over 56	39 - 56	38 or less	. .
8	July 1 - Sept. 11, 1978	over 60	49 - 60	35 - 48	35 or less

*Length categories determined from length-frequency distributions.

Table 2. Summary of the Number of Juvenile Atlantic Sturgeons Caught, Marked and Recaptured During Each Collection Period, According to Year Class

	Year class											
	1975 and older				1976				1977		1978	
			Recaptured‡				Recaptured‡					
Period*	Caught§	Marked†	Released	Dead	Caught§	Marked†	Released	Dead	Caught§	Marked†	Caught§	Marked†
1-2	326	316	0	0	. .	. .	. .	. .	. .	. .	. .	. .
3	748	692	1	0	25	25	0	0	. .	. .	. .	. .
4	1,066	826	12	1	138	135	0	0	. .	. .	. .	. .
5	369	272	5	5	33	27	0	0	5	2	. .	. .
6	930	552	11	1	90	90	1	0	6	6	. .	. .
7	357	332	11	1	285	284	2	0	37	37	. .	. .
8	256	246	7	0	279	273	6	0	103	103	22	1
8§§	15	15	1	0	46	46	1	0	16	14	1	0

*See Table 1 for dates covered by each period.

§Fish caught more than once during the same period as initially tagged are counted only once for that period.

†Represents number of marked fish released during the period and includes newly marked fish plus recaptured fish released alive.

‡Excludes fish caught during the same period as initially tagged. "Released" designates recaptured fish released alive; "dead" designates recaptured fish not released.

§§Additional specimens collected during this period which were used in making population estimates but not in other analyses.

various year classes based on length-frequency distributions. As shown in Table 1, a total of four year classes were distinguished, the 1975 and older classes being combined because the extent of overlap among them did not allow adequate separation.

A summary of the recapture histories of juvenile Atlantic sturgeons is shown in Table 2. A total of 56 recaptures from the 1975 and older year classes and 10 from the 1976 year class were considered valid for use in subsequent analyses. Excluded were recaptures of dead individuals found on shore, recaptures of individuals that had migrated to sea and recaptures of individuals tagged during the same period or adjacent periods separated by only a few weeks. Since specimens taken during each period were considered a single "instantaneous" sample, sturgeons caught twice during a period were handled as follows: they were counted once in the "catch" category for the period and once in the "new mark" category if released alive but zero in the new mark category if dead. This same procedure was applied to periods that were pooled in subsequent analyses.

POPULATION ESTIMATION MODELS The analytical model used to obtain population estimates for the combined 1975 and older year classes was originated by Jolly and is discussed thoroughly in Seber (1973:217-218). Briefly, the model assumes no recruitment, but it allows for mortality or permanent emigration. If there is recruitment, the recruits must be distinguishable from the older individuals and excluded. Population sizes at the start of the first through second to last time periods were estimated with the model. The population size for the last time period was estimated using mark/recapture data from the last two periods with the modified Peterson model (Seber, 1973).

The analytical models used to obtain population estimates for the 1976 year class were the Schnabel binomial model and Schumacher-Eschmeyer regression model discussed in Seber (1973:139-142) and Ricker (1975:96-97). Briefly, the models assume a closed population with a constant size, i.e., no recruitment or mortality. Of the two models, the regression model is more robust against violation of the assumptions. Close agreement between the estimates from the two models should indicate reliable population estimates.

RESULTS AND DISCUSSION

The findings of the investigation are presented with respect to the principal elements of the life history of the Atlantic sturgeon.

SPAWNING ADULTS

The movements of mature Atlantic sturgeons in the Hudson Estuary during the spawning season can be described as slow, deliberate, opportunistic (with respect to the tidal currents) and generally restricted to deeper areas where they move back and forth across the channel. Adults

apparently enter the Estuary in the spring of the year in which spawning occurs. There is no convincing evidence that the Hudson has both spring and fall migrations of the anadromous sturgeons as documented for Russian rivers (Berg, 1948) and the Caspian Sea (Classen, 1944), although observation of a few small adult sturgeons, probably males, in the lower Estuary during the fall was not defined as either immigration or emigration.

Mature male Atlantic sturgeons usually appear in the Hudson Estuary by early April before water temperatures rise above 6.0° C. (42.8° F.) and several weeks before the females are observed. It would appear that some males remain in the estuary until October or November. The males will generally be at least 12 years old, and their weights will range from 5.4 to 47.6 kilograms and their total lengths from 1.2 to 2.0 meters. Some of the smaller males may not be mature. Classen (1944) stated that the sex life of male sturgeons is short, some having a duration of 8 years. This is in apparent agreement with characteristics of male Atlantic sturgeons found in the Hudson.

Females are somewhat older and larger than males when they return to the Hudson to spawn for the first time. The youngest female for which age was determined was 18 or 19 years old and weighed 32.6 kilograms. The fish contained 3.6 kilograms of eggs which appeared ripe. Most mature females observed were 1.8 to 2.4 meters long and weighed 40 to 116 kilograms. A large female Atlantic sturgeon (224.0 centimeters, 77.1 kilograms), tagged near Poughkeepsie on June 15, 1977, returned to the Hudson in 1979 at which time it was 226.0 centimeters long and weighed 81.6 kilograms.

The statement by Vladykov and Greeley (1963) that "no female sea (Atlantic) sturgeons have been reported as ready to spawn before reaching at least 150 pounds and an age of about 10 years" is confusing, as is their statement that "the testes of the smallest ripe male was reported from a 70 pound fish". Females from the Hudson weighing 150 pounds are much older than 10 years, and females slightly over 100 pounds (45.3 kilograms) in weight have been found to have eggs appearing ripe. A male barely 1.2 meters long and weighing 5.4 kilograms possessed whitish testes, presumably ripe. The senior author has observed no adult Atlantic sturgeons in the Hudson Estuary more than 1.2 meters in total length that, when dissected, possessed obviously immature gonads, which would indicate inshore migration without participating in spawning. However, the possibility that immature Atlantic sturgeons 0.76 to 1.4 meters long and weighing 3.6 to 18.0 kilograms periodically visit estuaries other than their natal one prior to maturation (discussed under a later topic) makes it difficult to determine, with precision, the minimum age, length and weight of mature fish found in any estuarine system without examining the gonads of the specimen in question.

SPAWNING LOCATION

Gravid female sturgeons usually appear in commercial gill nets in upper Haverstraw Bay (kilometer 58) about the middle of May when water temperatures there are about 13.0° C. At that time of year, the salt front usually occurs in the same general area or slightly downstream. The presence of spent and partially spent females just above the salt front (off Montrose Point, kilometer 62) could indicate that spawning during the early part of the season (May) might take place in the vicinity of Stony Point (kilometer 64). As the season progresses, the salt front and the spawning activities apparently move progressively upstream but no further north than about Catskill (kilometer 182). Most spawning activity seems to occur between Croton Point (kilometer 56) and Hyde Park (kilometer 132) during the period May to August. Figures 3, 4 and 5 depict the movements of three adult sturgeons weighing 34.6, 25.8 and 74.8 kilograms as monitored by ultrasonic transmitters. These fish, presumably two males and a female, respectively, exhibited a common relationship to water flow regardless of whether their basic movement was upstream or downstream; they seldom swam against the current. Both males and females moved from side to side of the channel as if feeling their way along. Mature adults were not usually observed in water less than about 25 feet deep in the Hudson. Females seemed to exhibit a deliberate movement to and from the spawning ground whereas males seemed to meander about.

A male (Figure 4), tracked more than 40 kilometers up the estuary and back almost to the point of release, moved sporadically. When the fish was not riding with the current it did not backtrack more than about 1 mile. Continued movement would not always be initiated at the beginning of the next change of tide. On occasion, this male would remain stationary for hours; however, further movement was always begun soon after the beginning of a flood tide.

Females, in contrast to males, did not appear to stop for extended periods. Three females observed moved with every change of tide. A gravid 90.7-kilogram female (pattern not shown) tracked in the spring of 1977 moved 370 kilometers within a 35-kilometer reach of the estuary between Yonkers and Croton Point in little more than 2 weeks. Following its release in the vicinity of the interface between salt and fresh water off Bowline (kilometer 59) this fish moved upstream about 3.7 kilometers, but within 5 hours it turned and moved steadily downstream until it encountered brackish water. From that time on, the fish moved slowly up the salinity gradient in what superficially appeared to be the act of acclimation back to salt water. The movement pattern of this fish was simple when correlated with water salinity rather than geographical location, but 19 days after it was released the signal from its sonic transmitter could not be detected anywhere between Verplank (kilometer 66) and Manhattan (kilo-

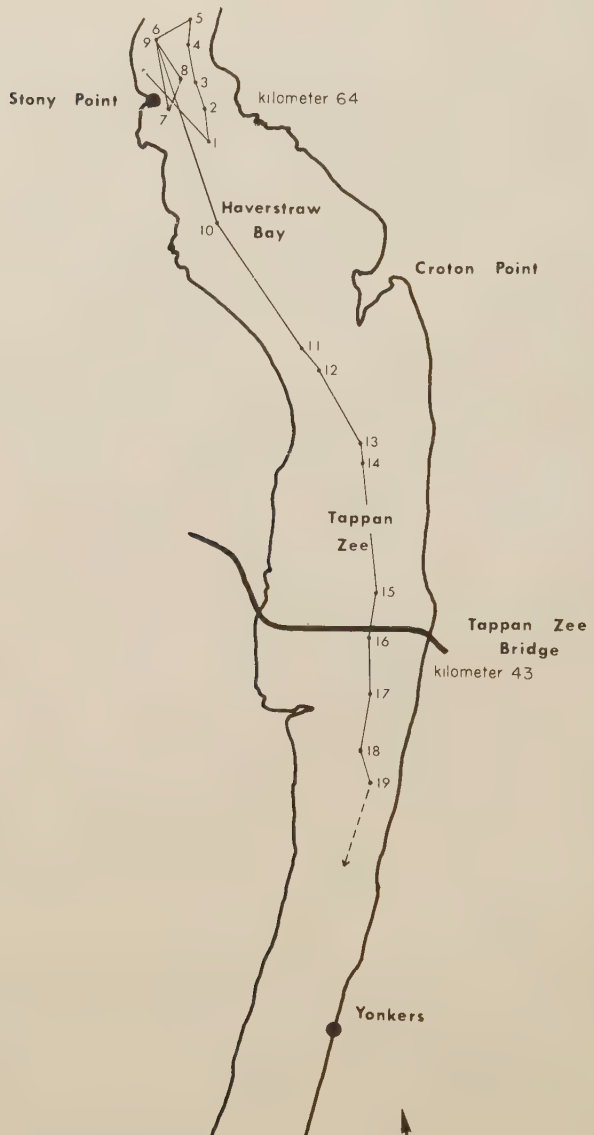

Figure 3. Pattern of movement of an Atlantic sturgeon (172.7 centimeters long and weighing 34.6 (kilograms) tagged with a sonic transmitter (70 Khz) on May 24, 1976 and monitored for 138 hours. Sex of fish unknown. Numerals refer to legend opposite.

Map No.	Date	Time	Elapsed time (hours)	Water temperature (°C.)	Remarks
*	May 24	13:40		11.5	fish released; salinity 0.0 ppt
	May 25	01:35		11.5	
		09:25		13.2	
1		10:45			caught in gillnet and released
		10:55			large sturgeon broke water
		14:30		14.7	
2		18:00			
3		18:25		15.5	
4		19:23			
5	May 26	03:30			off Texas Instruments site
		04:55		15.5	
		06:50		15.2	
6		07:35			under power lines
		09:30		15.2	
7	May 27	04:30			ebb tide
8		08:55			flood tide
9		10:15-22:40	69	11.5	back and forth under power lines, moving with current
9	May 28	03:00			moving south with ebb tide
10		04:30			
11		05:30	88		
		06:30			stopped
12		07:35			
13		09:22		11.7	
14		09:53		16.6	salinity 3.9 ppt
		10:16			
		12:45		11.5	slack water
		13:55			sturgeon broke water, transmitter—"pit-tooo"
		15:30	99	12.2	
15		16:45			ebb tide "2A"
16		17:25	101		
17		18:20			stopped
		19:21		10.5	
18	May 29	03:00			
		07:30		10.5	
19		11:30		15.8	salinity 4.4 ppt
19	May 30	07:00	138		
19	May 31	08:00			no signal

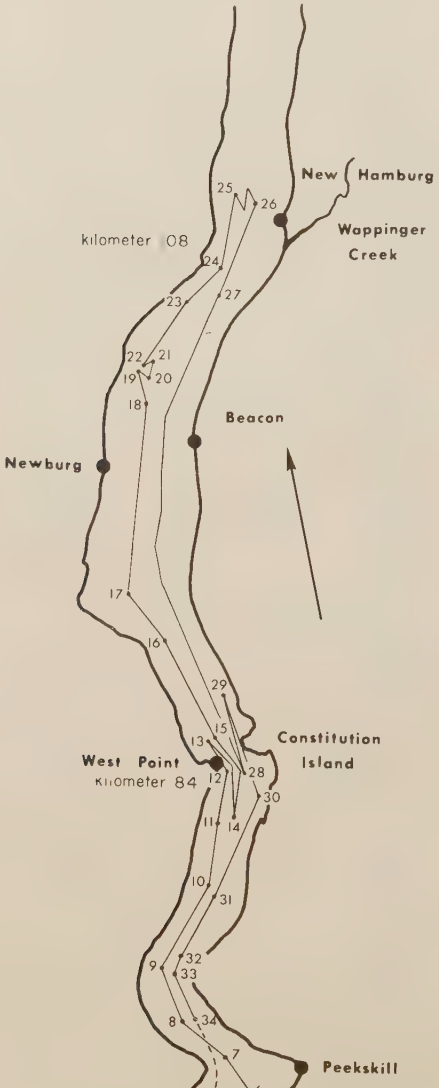

Figure 4. Pattern of movement of an Atlantic sturgeon (168.9 centimeters long and weighing 25.8 (kilograms) tagged with a sonic transmitter (55 Khz) on June 8, 1976 and monitored for 418 hours. Sex of fish unknown, but from streamlined appearance and weight it was probably a male. Numerals refer to legend opposite.

Map No.	Date	Time	Elapsed time (hours)	Water temperature (°C.)	Remarks
*	June 8	20:20		18.5	fish released; salinity 0.0 ppt
1		21:25			
2		22:35			
3	June 9	00:25			
4		02:07		18.7	
5		03:30			
6		06:30			
7		09:30			
8		10:00			
9		11:15	16	18.5	
10		21:15			
		22:30		19.2	
11		22:54			
12		23:10			
13		23:50			end of flood tide
14	June 10	03:00			
		07:55		20.0	
15		08:35			
16		22:17			
		22:45		20.0	
17		22:50	50		
18	June 11	20:19			
19	June 12	00:35			
20		08:45			
21		11:35			
22		12:35			
22	June 13	06:45			
		11:30		19.2	
22	June 14	09:30			
23		16:45	140	18.7	
24	June 15	17:45			
25	June 17	10:00			
26	June 18	12:30	232		
27	June 19	13:15			
28	June 20	17:00	285		
29		20:40		20.7	
30	June 21	05:30	297		
31	June 22	14:00		20.9	
32	June 23	18:30			
33	June 24	13:00		21.2	
34		19:00	382		
34	June 25	12:30			
34	June 26	06:15	418		
34	June 27	10:00			no signal

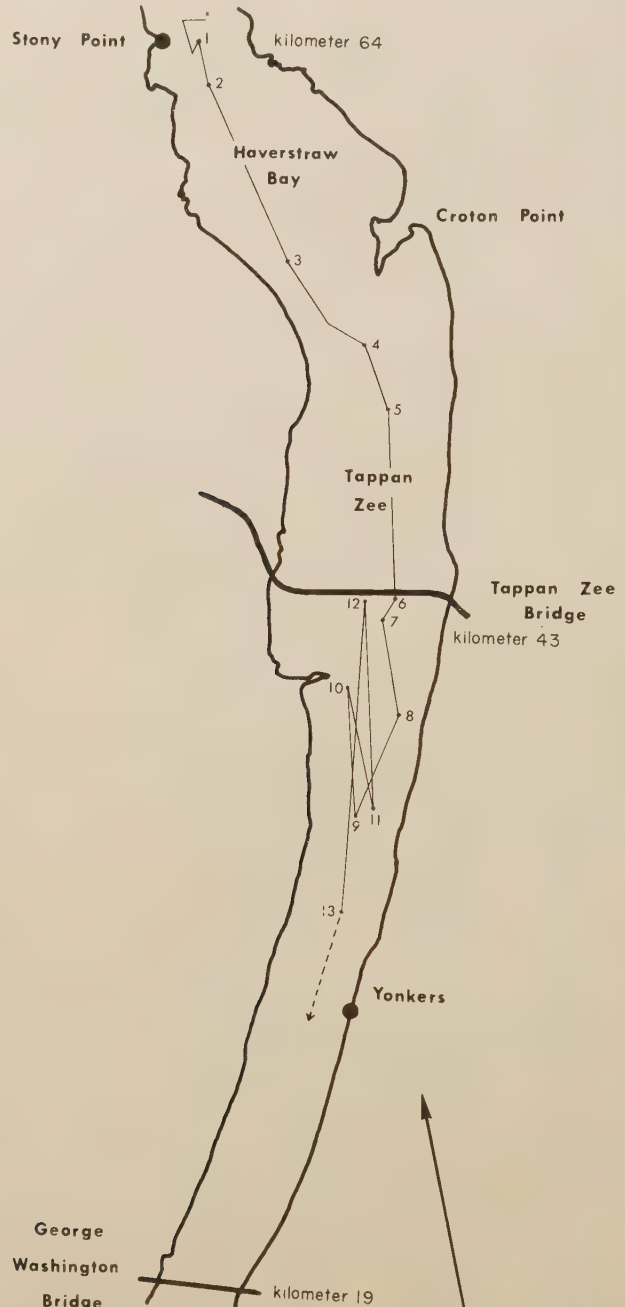

Figure 5. Pattern of movement of an Atlantic sturgeon (243.5 centimeters long and weighing 74.8 kilograms) tagged with a sonic transmitter (65 Khz) on June 25, 1976 and monitored for 138 hours. Sex of fish unknown, but probably a female. Numerals refer to legend opposite.

Map No.	Date	Time	Elapsed time (hours)	Water temperature (°C.)	Remarks
*	June 25	15:05			fish released
1		20:00		24.3	salinity 0.54 ppt; 6 feet of water; start of flood tide
		21:00-22:00			within a few hundred yards
2	June 26	00:45		22.3	salinity 4.8 ppt; moved against flood tide
		00:55			tide changed to ebb
3		05:30		22.2	salinity 3.8 ppt; moved with ebb tide
		09:00			tide changed to weak flood
4		11:15		22.6	salinity 6.2 ppt; moved against flood tide
5		13:50			moving with ebb tide
6		15:45	24	22.4	salinity 7.1 ppt; moving with ebb tide
7		20:30		22.2	salinity 7.7 ppt; flood tide
8	June 27	08:15		22.7	salinity 6.1 ppt
		19:15		25.7	salinity 6.6 ppt
10	June 28	02:15		22.4	salinity 7.5 ppt; off Piermont
		08:30		23.2	salinity 6.2 ppt; off Hastings
12	June 30	08:00			at Tappan Zee Bridge
13	July 1	09:00	138	24.5	salinity 5.2 ppt; off Palisades Boat Club, Yonkers; last known location—ship traffic (Operation Sail)

meter 9). The fish may have returned to the ocean, although there is a possibility that the battery in the transmitter failed by that time.

Mature male Atlantic sturgeons may be present in the lower estuary for up to 8 months during the warm season (April-November) each year. It is not known whether an individual fish will remain for the entire period. Mature females may remain in the estuary for at least a month and perhaps 6 weeks, based on the limited data collected through sonic tracking.

The time that a female Atlantic sturgeon spends on the spawning ground in the Hudson may be relatively short, from a few minutes to a few hours. The actual deposition of eggs probably occurs intermittently during this time. A 90.7-kilometer female, equipped with a sonic transmitter in the spring of 1976 and released 5.5 kilometers upriver from where it was captured in a gill net, returned to the vicinity of the same net within a few hours and sluggishly rose to the surface where, on the second ascent, it was recaptured and sent to the Fulton Fish Market in New York City. There, it was found to contain 10.4 kilograms of eggs and weigh 12.5 kilograms less than when tagged. The weight of the eggs plus the weight loss, which could have resulted from the deposition of eggs, equalled approximately 25 per cent of the total weight of the fish when tagged. A maximum egg complement of 25 per cent agrees with previous calculations for other large gravid female Atlantic sturgeons taken in the Hudson Estuary. The apparent intermittent deposition of eggs could explain differences in egg complements recorded in the literature. Figure 6 depicts the basic temporal and spatial movements of adult Atlantic sturgeons compared with those of adult shortnose sturgeons (*Acipenser brevirostrum*) in the Hudson. Subsequent movements of young are also shown.

A century ago, spawning of Atlantic sturgeons during August was reputed to take place in the Hyde Park area which was referred to as the center of the fishing industry for this species in the Hudson River (Anonymous, 1878). The capture on June 15, 1977 of a large, presumably gravid, female and two smaller males at Poughkeepsie 13 kilometers south of Hyde Park suggests a spatial occurrence that would fit the pattern of movement implied in the 1878 newspaper article and would agree with the pattern discussed here if the salt front during July 1878 was located south of Poughkeepsie. The 2:1 ratio of males to females in this group was generally similar to those of 3:1 and 1:1 for fish on spawning grounds as reported by Berg (1948).

Distribution of Larvae and Juveniles

Recently hatched and post-yolk-sac larvae and small juvenile sturgeons have been found between Kingston and Croton Point during May to July (Hoff et al, 1977; Texas Instruments, unpublished[4]). Unfortunately, the

[4]The senior author was permitted to examine small sturgeon specimens collected by Texas Instruments personnel prior to 1978.

Figure 6. Schematic representation of the basic temporal and spacial movements of Atlantic sturgeons and shortnose sturgeons in the Hudson Estuary. The Atlantic sturgeon is anadromous, while the shortnose sturgeon spends most of the time in fresh-brackish water habitat.

specimens reported by Hoff et al. (1977) were not identified to species, but they undoubtedly included at least a few larvae of the shortnose sturgeon which spawns north of Coxackie (kilometer 200) slightly before the Atlan-

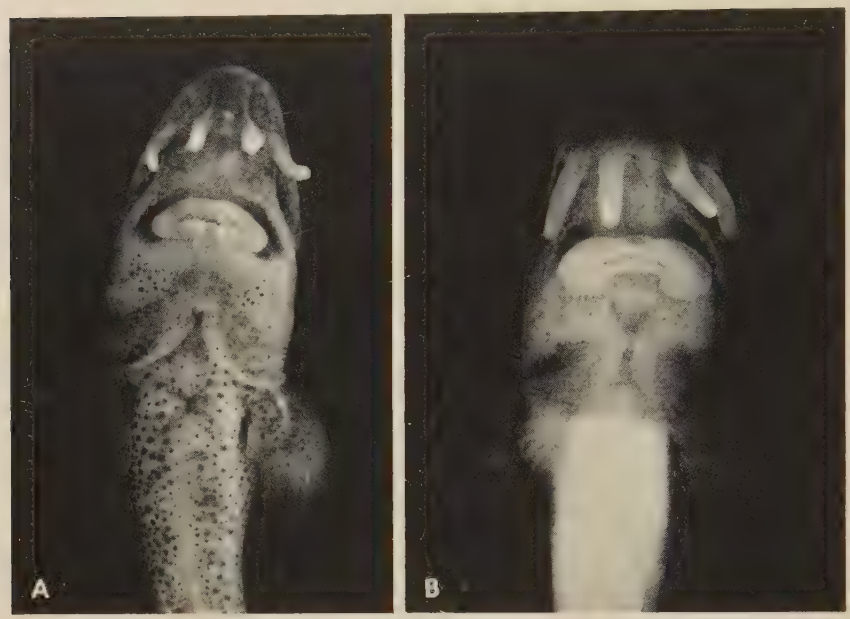

Figure 7. Comparative morphological characteristics of the mouth region of 17-millimeter larvae of (A) the Atlantic sturgeon and (B) the shortnose sturgeon. The prominent taxonomic difference is the width of the space between the lateral lobes of the fleshy mouth. This characteristic can be used to identify shortnose sturgeon larvae without having a specimen of the Atlantic sturgeon for comparison, whereas pigmentation, mouth width and barbel morphology can be confusing unless one has specimens of both species.

tic sturgeon (Dovel, 1981b). Figure 7 shows morphological characteristics in the mouth region of 17.0-millimeter larvae of the Atlantic sturgeon and shortnose sturgeon. While there are differences in pigmentation, shape and size of barbels and features of the mouth, the relative proportion of the space between the fleshy lateral lobes of the mouth to the width of the mouth appears to be a valid distinguishing characteristic between the two species of sturgeons during the post-larval and early juvenile stages. For the Atlantic sturgeon this space is usually much less than the width of the lobe or less than a third of the total width of the mouth.

Older juvenile and adult Atlantic sturgeons can also be distinguished from the shortnose sturgeon on the basis of mouth morphology, but not necessarily the relative width. Shortnose sturgeons have no distinct chin or neck as are prominent for the Atlantic species when the mouth is gently pulled out. While there are a number of other potentially distinguishing characteristics, the senior author has found those of the mouth as describ-

TABLE 3. CATCH OF JUVENILE ATLANTIC STURGEONS BETWEEN RIVER MILES 35 AND 43 IN THE HUDSON ESTUARY DURING VARIOUS MONTHS IN 1977 AND 1978, ADJUSTED TO A STANDARD UNIT OF EFFORT (TIME)*

Date	Number of tows	River miles	Catch per unit of effort§	Temperature (°C.)	Salinity (ppt)
			1977		
Mar. 10-15	10	39-43	0.420	2.4- 3.5	0.0
Mar. 15	3	35-38	0.944	2.2- 3.5	0.0
Mar. 22 - Apr. 2	8	40-41	0.844	3.3- 5.2	0.0-0.8
Mar. 28 - Apr. 1	5	36-38	1.507	3.2- 4.7	0.0-9.8
Apr. 5-13	8	36-38	0.503	6.1- 7.7	0.0
Apr. 14-28	8	35-38	0.302	9.2-11.5	0.0
Apr. 22-25	3	41-42	0.278	9.1-10.2	0.0
May 3-11	6	36-38	0.152	11.9-12.9	0.0
May 5-11	4	40	0.842	11.7-12.9	0.0
May 16	1	37-38	0.048	13.9	13.3
June 28-29	2	36-38	0.070	23.2-23.8	5.2-5.6
July 28	2	37-38	0.060	25.1	6.2
Aug. 22	1	36-38	0.250	. .	. .
Sept. 22	1	41	0.056	. .	. .
Sept. 21-28	6	36-38	0.266	21.0-23.5	0.2-5.5
Sept. 28-29	3	41-43	0.240	20.3	0.1
Oct. 5-6	3	36-38	0.460	17.3-17.8	0.0
Oct. 19-27	8	36-38	0.144	10.7-12.4	0.0-0.1
Nov. 3-9	3	36-38	0.051	12.0-12.7	6.6-8.4
Nov. 15-21	3	36-38	0.019	8.4- 9.0	0.0
Nov. 29	1	41	0.0	6.3	0.0
Nov. 29 - Dec. 8	3	35-38	0.037	3.5- 6.7	0.0-0.4
Dec. 16	1	41	0.100	1.9	0.0
Dec. 16-27	5	36-38	0.565	2.0- 2.4	0.0-7.0
			1978		
Mar. 30	3	41-43	0.244	1.6	0.0
Mar. 28 - Apr. 4	19	36-38	0.822	0.9- 4.7	0.0
Apr. 4-16	10	38	0.463	5.4- 6.9	0.0-0.5
July 6-13	3	36-38	0.050	21.0-24.2	5.6-9.9
July 18	1	36-38	0.067	24.2	6.6
July 18-25	10	41-44	1.047†	24.7-26.8	2.6-4.8
Aug. 7	1	36-38	0.040‡	25.4	6.2
Aug. 4-11	11	41-43	0.939†	25.4-26.3	2.5-5.6
Aug. 16-18	6	41-43	0.581†	27.2-27.4	3.2-3.8

*Sampling was limited to estuarine areas where a 35-foot semi-balloon otter trawl could be towed safely along the bottom, weather permitting. Most of the samples were taken from the dredged channel maintained at about 30-35 feet deep.

§Calculated for each year as the mean catch (total catch/total tows) divided by the mean effort (total time in minutes/total tows).

†At 50-foot depth.

‡At 35-foot depth.

ed here (lobe width, chin and neck) to be adequate and seldom confusing.[5]

The distribution of sturgeon larvae and juveniles during their first year

[5]It may be noted that, in comparison with specimens observed by the authors in the Hudson, Figure 3 or Murawski and Pacheco (1977) does not depict "a mature Atlantic sturgeon". Rather, it shows a juvenile with composite characteristics of fish 0.6 to 0.9 meters long. The midsection of the fish pictured is somewhat thicker than usually observed for fish from the Hudson, and the spines on the dorsal plates are typical of a small juvenile. Also, Figure 10 of Vladykov and Greeley (1963) depicts a juvenile Atlantic sturgeon with a slightly more upturned snout than the ones observed in the Hudson.

of growth has not been adequately defined. However, there is sufficient evidence to suggest probable patterns of distribution in the Hudson Estuary. The basic pattern of movement of larval stages of anadromous species, including the Atlantic sturgeon, is toward the ocean (Figure 6 and Dovel, 1981a). Accordingly, young-of-the-year Atlantic sturgeons and older juveniles will usually be found in the vicinity of brackish water. Comparison of the catch per unit of effort for immature fish in fresh vs. brackish areas of the lower Hudson Estuary during 1977 and 1978 (Table 3) did not provide a discrete indication of the occurrence of this age group in either water area, although most of the fish recorded were collected within 5.0 kilometers of the freshwater-saltwater interface. The erratic movement of the interface precluded a precise correlation between fish occurrence and the salt content of the water. No large catches of immature Atlantic sturgeons were made more than 5.0 kilometers upstream from brackish water, which may indicate that individuals of this age group orient to bradkish waters.

Age and Growth

Contrary to some general belief, Atlantic sturgeons do not grow at an unusually slow rate during the first three years, but growth slows after the third year (Figure 8 and Table 4). The rates of growth shown in Table 4 are the means for a combination of immature males and females remaining in the estuary after some fish had emigrated to sea. Growth by age group was based on calculated ages for 118 individuals and the subsequent

Table 4. Summer Growth of Juvenile Atlantic Sturgeons Collected From the Hudson Estuary, 1975-1978*

Age§ (years)	Number of specimens	Mean length (centimeters)		Increase
		Preceding growing season†	Following growing season‡	
1	4	32.5	47.5	15.0
2	5	53.7	63.9	10.2
3	8	63.1	71.0	7.9
4	1	71.0	74.5	3.5
Unweighted mean				9.2

*Includes only fish that were tagged prior to the growing season and then recaptured before the next growing season (or that were otherwise available for comparable measurement). Growing season considered to be period from May to October.

§Age during growing season based on June 1 birth date; age determined by length of specimen at time of tagging and increased 1 year to corespond to age at recapture.

†Represents mean length of these fish when tagged during the fall-spring (October-May) period preceding the growing season.

‡Represents mean length of these fish when recaptured during the fall-spring (October-May) period following the growing season.

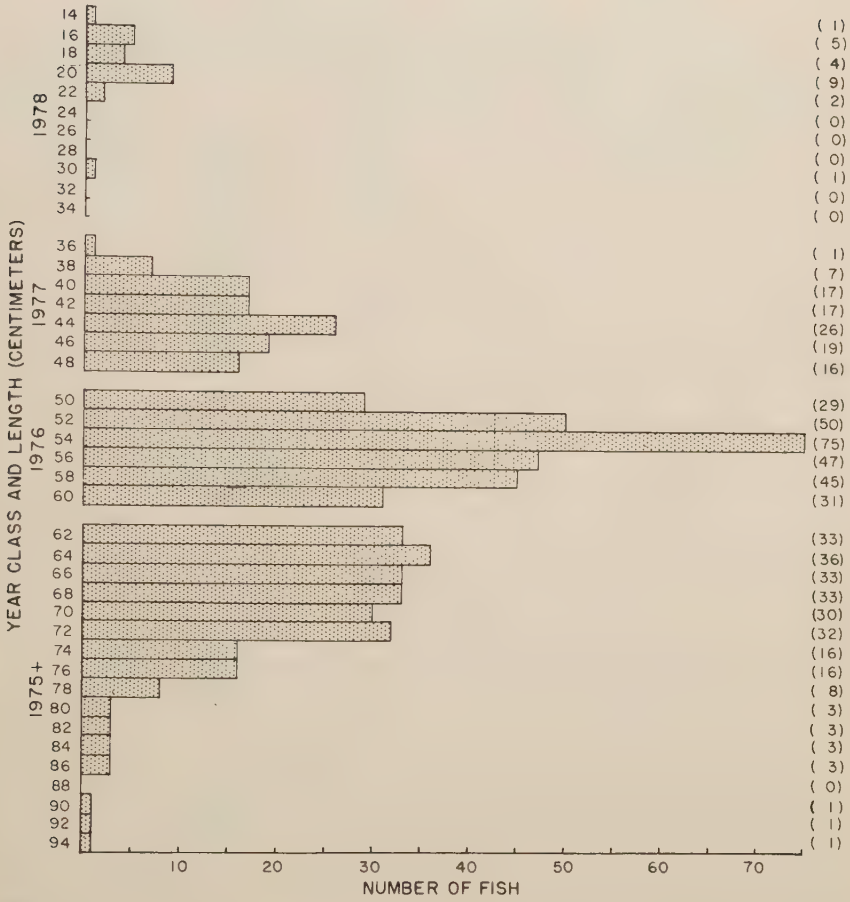

Figure 8. Length-frequency distribution of juvenile Atlantic sturgeons according to year class for fish collected in the Hudson Estuary from July 1 to August 21 in 1978. Most of the collections were made between river kilometers 56 and 69 with a 35-foot semi-balloon otter trawl. Figures in parentheses represent number of fish and total 252, 277, 103 and 22 for the year classes 1975 and older, 1976, 1977 and 1978, respectively.

recapture of marked fish. Most of the annual growth occurred during the period May to October when recaptured juveniles from 1 to 4 years old grew between 2 and 18 centimeters. There was essentially no growth from October to May.

Juveniles attained lengths of about 50 + centimeters during their second growing season when about 18 months old (age 1), 60 + centimeters during their third growing season when about 30 months old (age 2) and 70 + centimeters during their fourth growing season (age 3) as shown in Figure 9. Growth during the fifth and subsequent growing seasons, for juveniles that remained in the estuary, declined rapidly. It seems probable that

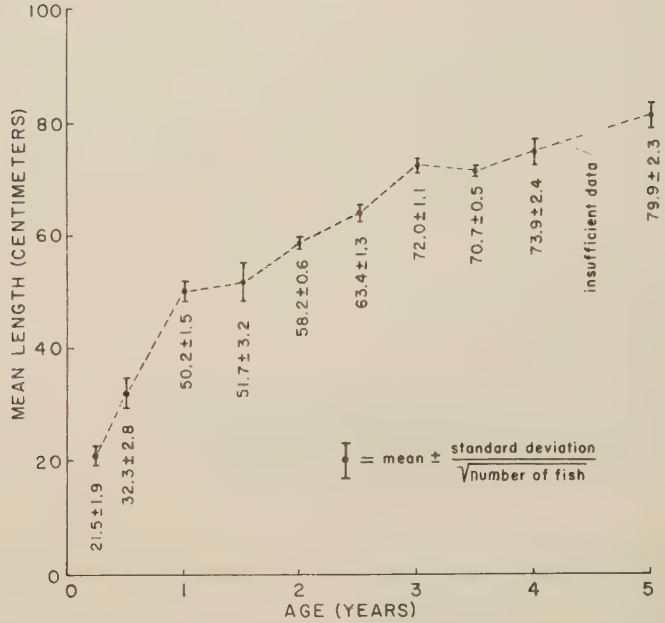

Figure 9. Growth of juvenile Atlantic sturgeons in the Hudson Estuary during their first five years of life in terms of mean total length. No differentiation was made between males and females.

males leave the estuary first, some as young as 1 + years, and that the fish remaining more than 5 years are predominately females.

Increases in mean length for four age groups of tagged sturgeons during the May-October growing season ranged from 15.0 centimeters for 1-year-old fish to 3.5 centimeters for 4-year-old fish. The unweighted average growth for the four groups combined was 9.2 centimeters per year. Generally similar results were observed during the growing season for untagged fish. However, the untagged fish exhibited a slightly greater mean growth (10.4 centimeters) than the tagged fish. Maximum growth for untagged fish ranged from 2.1 to 18.4 centimeters.

The growth rate of juvenile Atlantic sturgeons in the Hudson Estuary is greater than previously documented and is generally similar to that of southern populations during the first few years. The age-length determinations made during this study for this age group differ from those given by Murawski and Pacheco (1977: Table 8). The authors believe that this may be attributed to two factors. First, the ages recorded by Murawski and Pacheco were determined from otoliths, which are far more difficult to read than pectoral rays. Second, many of the juveniles examined during the present investigation possessed false annuli that appeared to be correlated with or laid down about the time of the mass downstream migration of sturgeons in the fall. The false annuli occurred annually and may

TABLE 5. LENGTH AND WEIGHT, ACCORDING TO AGE, OF ATLANTIC STURGEONS COLLECTED FROM THE HUDSON ESTUARY, 1975-1978*

Age (years)	Variable	Number of specimens	Measurement§	
			Mean	Standard deviation
0	Length	4	21.50	3.87
	Weight	3	0.07	0.01
0.5	Length	6	33.33	6.88
	Weight	6	0.15	0.08
1	Length	6	50.23	3.62
	Weight	6	0.50	0.11
1.5	Length	3	51.67	5.53
	Weight	3	0.46	0.06
2	Length	40	58.24	4.01
	Weight	40	0.77	0.15
2.5	Length	11	63.41	4.22
	Weight	11	1.00	0.22
3	Length	30	71.99	5.79
	Weight	30	1.59	0.42
3.5	Length	4	70.70	1.01
	Weight	4	1.35	0.28
4	Length	10	73.92	7.44
	Weight	10	1.71	0.55
5	Length	4	79.85	4.54
	Weight	4	2.44	0.33
12	Length	2	134.30	21.07
	Weight	2	17.15	9.98
13	Length	5	144.80	17.98
	Weight	5	17.96	6.97
14	Length	9	155.46	16.45
	Weight	8	23.62	6.25
15	Length	5	161.94	4.45
	Weight	5	26.85	4.63
16	Length	1	157.50	. .
	Weight	1	25.00	. .
17	Length	1	188.00	. .
	Weight	1	38.10	. .
18	Length	1	182.90	. .
	Weight	1	32.66	. .
19	Length	2	193.05	14.35
	Weight	2	41.05	12.51
20	Length	2	203.00	21.21
	Weight	2	60.10	24.06
22	Length	1	208.00	. .
	Weight	1	82.55	. .
26	Length	1	228.60	. .
	Weight	1	77.79	. .
28	Length	2	232.40	5.37
	Weight	2	86.19	6.41
29	Length	1	238.80	. .
	Weight	1	98.88	. .

*Fish 12 to 22 years old were primarily males; those 22 to 29 years old were primarily females.
§Length represents total length in centimeters; weight in kilograms.

indicate a break in the feeding patterns of migrating fish (about October) before total cessation of feeding during the winter (December-January). It is interesting that shortnose sturgeons of the Hudson Estuary, which do not undergo a pronounced fall migration like that of the Atlantic sturgeon, do not possess obvious false annuli.

Table 5 provides growth information for Atlantic sturgeons less than 29 years old occurring in the Hudson Estuary. No mature male has been found over 20 years old and no mature female less than 18 or 19. As a general rule, Atlantic sturgeons over 2.0 meters long and 27.6 kilograms in weight found in the Hudson are mature females.

Fall Migration

As water temperatures in the upper Hudson Estuary drop below about 20° C. a downstream mass migration of immature Atlantic sturgeons begins. By the time the temperature drops below about 9° C. most of the immature sturgeons that stay in the river seem to have congregated at locations where they will remain until spring. It would appear that this behavior is initiated by the decline in water temperature, strongly influenced by water salinity, but with substrate type replacing water salinity as the primary factor determining winter habitat as water temperatures approach seasonal minima. As a general rule, this mass downstream migration is at its peak in Haverstraw Bay about the third week of October when water temperatures there are between 12° and 18° C. As water temperatures approach their winter minima, the immature sturgeons seem to seek out channel holes or pockets, primarily between the Bear Mountain Bridge (kilometer 74) and the George Washington Bridge (kilometer 19), where they remain regardless of fluctuations in water salinity during the winter.

Some immature Atlantic sturgeons leave the Hudson Estuary at this time. Emigrating fish are at least 1 year and 3 months but not more than 6 years of age. Some, if not all, of the emigrants go south along the Atlantic coast in the fall and probably north in the following spring as reported by Holland and Yelverton (1973). Tagged juveniles have been recaptured throughout a 1,296-kilometer area of the mid- and north Atlantic coast between Marblehead, Massachusetts, and Ocracoke, North Carolina, (Figure 10) with recaptures coming from various types of commercial fishing gear. While evidence to date indicates that the emigration of juveniles from the Hudson takes place in the fall as a continuation of the downstream movement, emigration in the spring should not yet be ruled out.

During the period of September to November, a few large male Atlantic sturgeons (more than 1.0 meter long) are often observed in the Hudson prior to the onset of the cold season. It is assumed that these fish are moving out of the estuary. However, male sturgeons, like striped bass, could move inshore in the fall in preparation for spawning in the spring.

Figure 10. Distribution of Atlantic sturgeons tagged as juveniles in the Hudson Estuary and recaptured by commercial fishermen along the Atlantic coast between Marblehead, Mass. and Orocoke, N.C. Most of these fish were tagged between river kilometers 56 and 69 in the estuary during the period 1975 to 1978. Numbers designate sequence of recapture. These data seem to indicate a southerly migration in the fall and a northerly migration in the spring.

The migration of a tagged 56.0-kilogram sturgeon out of the Hudson sometime after June 11, 1976 and into the Delaware River system where it was captured on March 17, 1977 is an interesting situation. The fish may have been capable of spawning when it visited the Hudson during the spawning season in 1976. In March 1977, almost a year later, it occurred in the Delaware River at the time males native to that system should have been arriving there to spawn. Obviously, this young male travelled into and out of at least two estuarine systems, at least one of which could not have been its native stream. A partial explanation for this movement has been obtained through the recovery of tags placed on fish in the Hudson. Of all the Atlantic sturgeons tagged during this study, 61 (almost 1.5 per cent) have been recovered outside the Hudson. Several were recaptured as far away as lower Chesapeake Bay or in North Carolina waters 5 to 7 months after they had been tagged. Undoubtedly these fish moved into other estuarine areas along the coast before returning to the Hudson to spawn. There is no reason to believe that these migrating immature sturgeons would not have continued to move in and out of several estuarine systems prior to the time they returned to their native stream to spawn.

Obviously, the Hudson Estuary makes a substantial contribution to the Atlantic coastal stock of the Atlantic sturgeon, perhaps the dominant contribution for rivers between Maine and North Carolina. There is a possibility that sturgeons tagged in North Carolina waters by Holland and Yelverton (1973: Table 11) were fish native to the Hudson Estuary. The 9.5-kilogram sturgeon (Tag No. A0.006) tagged on March 21, 1968 at Avon (N.C.), and recaptured on May 25, 1968 in Mecox Bay on Long Island (N.Y.)[6], was in the size range of sturgeons that would be found outside their native streams, judging by characteristics of fish that emigrated from the Hudson. At any rate, the migration of this fish to New York waters indicates northerly movement in the spring and extensive migration of juvenile fish after they have left their native stream and prior to spawning.

Some larger juvenile Atlantic sturgeons (0.6 to 1.0 meter long) observed in the Hudson shortly before emigration exhibited pronounced variations in snout morphology for fish of similar length. The authors speculate that rounder, more developed features may indicate a sexual characteristic, but it is not known whether this would represent advanced development of males soon to leave the estuary or development of females that remain in the natal stream. Fish age has not been correlated with snout development, but it should be helpful in assessing the significance of the variations observed.

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[6]The recapture location was given by Holland and Yelverson (1973) as "Mecocks, (Long Island) New York", but this is not a valid name and the authors consider it a spelling error.

WINTER DISTRIBUTION IN THE HUDSON ESTUARY

Most, if not all, of the Atlantic sturgeons present in the Hudson Estuary during the period of December through March are immature fish that congregate in deep areas (more than 25 feet) mostly in the section between the Bear Mountain Bridge and the George Washington Bridge. The fish occur in both fresh and brackish waters. No evidence was found to indicate that immature sturgeons congregating in the lower estuary are sensitive to subtle changes in water salinity or that mature sturgeons are present in the estuary during this period.

In view of the distinct emigration characteristics observed for juvenile Atlantic sturgeons less than 6.5 years old reared in the Hudson Estuary, it seems plausible to consider these waters a primary spawning and nursery area for this species. The apparent lack of immature fish older than 6.5 years in the Hudson, coupled with the obvious emigration of younger fish, might indicate that other mid- and north Atlantic estuarine ecosystems do not produce as many young Atlantic sturgeons to participate in interestuarine exchange as does the Hudson Estuary.

SPRING MIGRATION IN THE HUDSON ESTUARY

A slight rise in water temperature in the spring apparently stimulates immature fish to move upstream from the areas where they congregate during the winter. Vladykov and Greeley (1963) referred to this as "definite mass movements". At this time, as well as in the fall, immature sturgeons are found in areas less than 25 feet deep where they do not usually occur during the warmer periods of the year. By mid-April immature fish have been observed as far north as Esopus Meadows (kilometer 140) where water temperatures at the bottom (50 feet) were 9° C. No evidence was found to suggest that juveniles leave the Hudson Estuary at this time.

As summer approaches, water temperatures in shallower areas rise to a level which apparently stimulates Atlantic sturgeons to seek deeper, cooler areas. The summer distribution of juveniles has not yet been entirely delineated. However, on July 18, 1978 a large concentration of juveniles was found in 50 feet of water at kilometer 69 where water temperatures were 24.2° to 24.7° C. and salinities were 4.2 to 4.3 ppt. On the same date a 45-minute tow of a trawl with a 35-foot headrope in Haverstraw Bay produced only three juvenile sturgeons in waters of slightly higher salinity, the area where sturgeons concentrated in the winter. The concentration of immature sturgeons in waters with low salt content (0.0 to 6.0 ppt, Table 3), if a valid indication of distributional preference, would support the contention (Dovel, 1971, 1981a) that areas of low salinity in coastal estuaries are the critical nursery habitats for the early immature stages of anadromous species.

Population Estimate For Juvenile Atlantic Sturgeons

The estimated population size of the combined 1975 and older year classes in the Hudson Estuary remained in the vicinity of 100,000 from March 1976 to March 1977 (Table 6). By July it had dropped to about

Table 6. Population Estimates For the Combined 1975 and Older Year Classes of Juvenile Atlantic Sturgeons in the Hudson Estuary at the Start of Each Sampling Period*

Period§	Date at start of period	Estimated population	
		At start of period	Confidence interval (95 per cent)
1-2	March 1976	106,521	41,654 - 171,388
3	October 1976	120,882	62,534 - 179,230
4	March 1977	99,117	49,742 - 148,492
5	July 1977	60,546	12,820 - 108,272
6	October 1977	38,964	12,608 - 65,320
7	March 1978	45,312	0 - 133,616
8†	July 1978	45,288	6,478 - 1,000,000+

*Calculated according to Jolly model (Seber, 1973) which assumes no recruitment but allows for mortality of permanent emigration, and also assumes that sufficient mixing occurs between December and March to assure randomness with respect to mark status.

§See Table 1 for dates covered by each period.

†Estimate for this period based on the modified Peterson model (Seber, 1973) using data for periods 7 and 8 only, which comprised 332 marked fish and 271 subsequently collected fish of which one was a recapture.

60,000 and by October 1977 to about 40,000 where it remained until the beginning of July 1978. The drop probably corresponded more to emigration of members of the 1974 and older year classes than to mortalities. The Jolly (no recruitment) model upon which these population estimates were based allows for mortality or permanent emigration. A violation of one assumption of the model related to equal probability of survival of individuals within the marked segment of the population. Not all members of the 1975 and older year classes had an equal probability of emigrating since emigration begins at age 1 and increases through age 5 after which no juveniles remain in the riverine population. Therefore, survival for the marked population was not independent of age. However, the violation is not critical provided survival is independent of mark status and the probability of capture independent of age (Seber, 1973). Difference in survival between marked and unmarked individuals within these year classes should have been low due to the size of the specimens and the sturgeon's hardiness to handling. The probability of capture should have been independent of age since the trawl and gill nets were not greatly selective against fish of this size. However, young of the year and yearlings were not selected by the gill net because of their small size.

The estimated population size of the 1976 year class, based on both the Schanbel and Schumacher-Eschmeyer models, was approximately 26,000 assuming a closed population from October 1976 to September 1978,

TABLE 7. POPULATION ESTIMATES FOR THE 1976 YEAR CLASS OF JUVENILE ATLANTIC STURGEONS IN THE HUDSON ESTUARY, ACCORDING TO TWO MODELS, ASSUMING A CLOSED POPULATION OVER TWO TIME PERIODS.

Closed population assumed* (time period)	Estimation model	Estimated population	
		Number	Confidence interval (95 per cent)
October 1975 to September 1978	Schnabel	25,647	13,206 - 53,039
	Schumacher-Eshmeyer	27,319	20,360 - 41,505
July 1977 to September 1978	Schnabel	23,729	9,966 - 64,447
	Schumacher-Eshmeyer	23,370	12,713 - 144,528

*Constant population size, i.e., no recruitment or mortality.

whereas it was about 23,500 assuming a closed population during the shorter period of July 1977 to September 1978 (Table 7). Since the trawl was the primary gear used to collect individuals of this year class, problems of recruitment due to gear selectivity were reduced. However, the low catches from October to December in 1976 may indicate that the young of the year had not yet been fully recruited to the deep channel waters where most trawl samples were taken. Nevertheless, the close agreement between the estimates under both assumptions indicates that the size of the 1976 year class was in the neighborhood of 25,000.

Based on available data, the following general comments may be made about the size and numbers of juvenile Atlantic sturgeons in the Hudson Estuary at different times, under the conditions observed during this study.

1. The calculated estimate of approximately 100,000 fish represented the catchable segments of up to six year classes, not including most young-of-the-year fish which were not adequately sampled.
2. The estimate of about 25,000 fish for the 1976 year class in 1978 represented fish that had been in the river with little probability of emigration.
3. Of the maximum of size year classes that could be represented by individuals in the river at any one time, it seems logical to assume that a meaningful population estimate would equal about four classes each equivalent to the calculated size of the 1976 year class (25,000) or about 100,000 fish, the estimate derived for the composite 1975 and older fish in 1976 and 1977 (Table 6).
4. It has not been possible to estimate the number of adult Atlantic sturgeons in the Hudson Estuary during the spring spawning season.
5. The inability to adequately sample young-of-the-year Atlantic sturgeons complicates efforts to estimate population size.

Assessment of the life history characteristics of the Atlantic sturgeon in the Hudson Estuary as derived through this investigation indicates that the

following regulations with respect to taking this species in the estuarine waters of New York would constitute good management of the population under present conditions. Further, since Atlantic sturgeons should exhibit similar characteristics in the other estuarine systems along the Atlantic coast of North America, the rationale supporting the regulations could be considered, with specific regional modifications, generally applicable throughout this area. This might serve as a basis, through application of size limits commensurate with local growth rates, for achieving greater uniformity in the regulations of the different coastal states. The principle involved would also be applicable to the exploitation of sturgeons native to the estuarine systems of the United States but caught by foreign fishing fleets.

Regulation	Rationale
1. Prohibition of the taking of Atlantic sturgeons under 48 inches (122 centimeters) in total length in the estuarine and riverine waters of the Hudson Estuary north of its confluence with the Atlantic Ocean (Verrazano Bridge)	a. All Atlantic sturgeons under 48 inches long found in the Hudson Estuary to date were apparently immature. b. A 48-inch minimum length would give most male fish a chance to mature and return to spawn. c. Juvenile sturgeons less than 48 inches long, that were reared in the Hudson, occurred in other inshore estuarine areas after leaving the Hudson. The 48-inch minimum length, if adopted in other coastal areas, would protect all sturgeons smaller than this. d. This size limit would also protect immature individuals of a northern population that would be as large as mature individuals of a southern population when northern fish enter southern waters if migration to this extent takes place.
2. Prohibition of the taking of Atlantic sturgeons under 72 inches (183 centimeters) in total length from New York coastal waters over the continental shelf.	a. Female Atlantic sturgeons do not appear to return to the fresh waters of the Hudson Estuary, presumably to spawn, for the first time until they are about 183 centimeters long. b. Although mature males less than 183 centimeters long could occur with immature females in coastal waters, it is doubtful that commercial fishermen could separate the sexes.
3. If deemed necessary, prohibition of all fishing in the navigational channel of the Hudson Estuary south of the Federal lock at Troy-Albany.	a. Mature Atlantic sturgeons were usually found in waters more than 7.6 meters deep. A channel free from all fishing would provide escapement for spawning adults.

Changes in the statue of the sturgeon population would necessitate modification of the regulations in effect. If the population level should decline, the following regulations would further restrict the harvest.

4. Prohibition of the taking of adult Atlantic sturgeons in the Hudson Estuary prior to July 1 each year.	a. Large, gravid females usually arrived in Haverstraw Bay between May 15 and June 5. While some large females and males were present in the lower Estuary between April 15 and November, this measure would permit commercial fishing but safeguard the peak spawning run of the largest females.
5. Prohibition of fishing for sturgeons in areas of low salinity (0.5 to 10.0 ppt) in the Hudson Estuary.	a. Available information indicates the possibility that many of the juvenile Atlantic sturgeons in the Hudson Estuary, primarily 2-, 3- and 4-year-old fish, congregated in areas of low salinity during the summer prior to emigrating from the Hudson.

Consideration of the degree to which management regulations developed for one region may be applicable in other regions brings up an important question: do the migrational habits of different populations place immature and mature individuals of a similar size in a common area? Similarly, it would be desirable to know if the basic growth pattern for an anadromous species is applicable to the entire geographical area throughout which immature individuals of the species migrate. Such knowledge would be of great value in determining regional management jurisdiction. The investigation of the Atlantic sturgeon in the Hudson Estuary has increased knowledge of the Hudson's contribution to the sturgeon population of the Atlantic coast, possibly a dominant contribution, and should stimulate concerns for coastwise management efforts.

Finally, it would appear that better management of coastal stocks of the Atlantic sturgeon will be feasible once regional life history characteristics are known, thus permitting appropriate modifications in basic management policy in keeping with specific regional growth characteristics of the fish. The needed data could be derived through research conducted in two general areas, i.e., the mid- and north Atlantic coast, and the south Atlantic coast. Merging the data from such an effort should provide an adequate base from which a multi-regional management policy could be developed while maintaining the integrity of each region.

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RELATIONSHIP OF DEGREE AND COMPOSITION OF WINTER MORTALITY OF DEER, AS INDICATED BY STRIP SURVEYS, TO SEVERITY OF THE WINTER[1]

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ABSTRACT

Strip surveys were made in deer wintering areas, mainly in the Adirondack region, to determine the relative mortality from year to year. There was a positive correlation with the severity of the winter as indicated by the number of days with snow depths of 20 inches or more. In the Adirondacks, starvation was the principal cause of death, and losses were greatest among fawns. Although data collected by strip surveys in the same area can indicate annual trends, they represent only the strips surveyed and cannot be converted to estimates of actual mortality over a wider area. Nevertheless, such surveys can serve as a means of informing the public regarding the status of the range and the effect of winter conditions on deer abundance.

A number of studies have shown that winter mortality of deer is correlated with the severity of the winter (Severinghaus, 1947, 1972; Verme, 1968) and that losses among fawns are greater than those among adult deer (Doman and Rasmussen, 1944; Rausch, 1950; Martin and Krefting, 1953; Severinghaus and Cheatum, 1956; Robinette et al., 1957). Further data on these relationships were obtained during strip surveys for dead deer in major wintering areas in New York.

METHODS

The technique described by Severinghaus (1961) was used to survey deer wintering areas in the Adirondack region where overpopulation and starvation are chronic. Crews worked strips of predetermined width (75, 100, 150 or 200 feet) along watercourses in these areas and recorded all dead deer found. The number of square miles covered was calculated from the linear miles walked and the width of the strip, and from that the number of dead deer per square mile was determined. Since data from such surveys from year to year in the same areas should reflect the relative degree of mortality, major yarding areas were designated for annual survey and were termed "trend yards". They are listed in Table 1. Surveys of this sort were begun by research personnel on a few areas in 1944, but the most extensive coverage was from 1962 to 1970. In addition, surveys were made at various times in other deer yarding areas (i.e., "non-trend yards") by management personnel to provide information on specific problems. These are listed in Table 2.

Also, strip surveys were made along permanently established random

[1]A contribution of Federal Aid in Fish and Wildlife Restoration Project W-89-R.

Table 1. Trend Yards in the Adirondack Region Used For Assessing the Relative Winter Mortality of Deer From Year to Year

County	Town	Deer yard
Essex	Elizabethtown	Cobble Hill, Roaring Brook
	Minerva	Aiden Lair, Boreas River, Vanderwacker Brook
	Newcomb	Beaver River, Hudson River, Hyslop Brook
	North Hudson	Brace Dam, Durgin Brook, West Mill Brook, Wolf Pond
Franklin	Altamont	Derrick
	Belmont	Salmon River, Wolf Pond
	Brighton	North Branch Saranac River, Slush Pond
	Brighton, Santa Clara	Osgood River
	Duane, Brighton	DeBar Mountain, Hayes Brook
	Santa Clara, Duane	Clear Brook
	Waverly	Adler Brook, Azure Mountain Club, McCavenaugh Pond, Stony Brook
Hamilton	Inlet	Moose River Plains
	Lake Pleasant	Hatchery Brook, Mud Lake
	Wells	Whitehouse
Herkimer	Webb	Balsam Flats, Five Ponds, Little Safford Lake Outlet, Wolf Lake
Lewis	Highmarket	Big Alden, Highmarket
	Osceola	Osceola, Salmon River, Tug Hill
St. Lawrence	Clifton	Peavine Swamp
	Clifton, Clara	Cook's Pond Outlet, Newbridge
	Colton	Chandler Pond, Gleason's Mills, Grass River Club
	Fine	Glasby Creek
	Fine, Webb	Nick's Pond
	Piercefield	Horseshoe Lake
Warren	Johnsburg	Cook Brook, Diamond Brook, Fox Lair, Kibby Brook, Martha Brook
	Stony Creek	Bakertown, Harrisburg

lines in two other yarding areas, the Moose River plains in Hamilton County and Lordville in Delaware County. It was hypothesized that data from these random lines could be expanded to estimate losses over the entire area from which the lines were selected.

The surveys were made annually in the early spring after snow melt (April-May). All deer carcasses found along the survey lines were recorded, as well as the following data insofar as possible.

Sex: determined by external features if present; otherwise, skulls were examined for antler pedicels or pelvic girdles were examined for evidence of sex.

Age: determined by tooth replacement and wear.

Cause of death, determined as follows:

Starvation: femur was examined for fat content of the bone marrow; only deer with red gelatinous marrow (fat content less than 10 per cent) were considered to have died of starvation.

TABLE 2. NON-TREND YARDS IN THE ADIRONDACK REGION USED FOR ASSESSING THE RELATIVE WINTER MORTALITY OF DEER

County	Town	Deer yard
Clinton	Dannemora	Indian Point, Rocky Brook
Essex	Newcomb	Goodnow River
	North Hudson	New Pond Outlet
Franklin	Altamont	Cold Brook, Mountain Pond, River Pond
	Belmont	Figure Eight Pond
	Brighton	Blind Brook, Clear Pond, Dan Brook, Loon Pond
	Duane	Duquay Brook
	Santa Clara	Rice Brook
	Waverly	Middle Branch St. Regis River
Fulton	Oppenheim	Lassellsville
Hamilton	Arietta	Celler Brook, Forked Lake, Marion River Carry, Pine Brook, Piseco Lake, Silver Run
	Indian Lake	Loon Brook, Rock River
	Inlet	Bear Pond, Red River
	Inlet, Morehouse, Arietta	Moose River
	Lake Pleasant	Dunham Brook, Fawn Lake, Hamilton Lake, Indian Clearing, Jessup River, Place Brook
	Long Lake	Big Brook, Bog Stream
	Morehouse	Metcalf Brook
	Wells	Forks Mountain, Gilman-Charlie Lake, Hayes Brook, Kunjamuk River, Robbs Creek
	Wells, Hope, Benson	Northville, Wells
Herkimer	Ohio	Black River, Nobleboro, North Lake Road, South Lake Outlet
Lewis	Croghan	Long Pond, Number Four
	Greig	Tommy Roaring Brook
	Rodman, Pickney	Barnes Corners
Oswego	Redfield	Otto Mills
Saratoga	Day	Farrell Place
St. Lawrence	Clifton, Colton	Cranberry Lake Club, Dead Creek
	Colton	Balsam Pond, Sampson Pond
	Piercefield	Bog River
Warren	Johnsburg	County Line Brook, Shanty Brook
	Thurman	Garnet Lake, Madison Creek
	Warrensburg	Pack Forest
Washington	Salem	Beattie Hollow, Blind Duck Hollow, Buttermilk Falls Brook, Camden Valley, Perkins Hollow
	White Creek	Brownell Hollow, Chestnut Woods
	White Creek, Jackson	Ash Grove

Other: crippling losses could be identified by bullet wounds, highway deaths by trauma and broken bones, and dog kills by the manner in which the flesh had been torn from the hindquarters.

In many instances, carcasses had been so badly torn apart and carrionized that some or all of these data could not be determined.

Severity of the winter was judged on the basis of the duration of deep snow. Depths of 20 inches or more restrict deer movement (Severinghaus, 1947), causing the animals to congregate in the softwood portions of yarding areas where food tends to be scarce and usually chronically overbrowsed. The average number of days with snow depths of 20 inches or more (i.e., critical snow days) at six stations of the U.S. Weather Service (Boonville, Lake Placid, Newcomb, Old Forge, Speculator and Wanakena) was determined for each year from 1955 to 1970 as an index to winter severity in the central Adirondacks. Records from the station at Fishs Eddy were used for the Lordville area.

FINDINGS

Only the surveys on the trend yards, the Moose River plains and the Lordville area provided data that permitted sound comparisons of mortality from year to year. However, records for the non-trend yards could be used for comparing age and sex ratios of winter-killed deer.

Relative Annual Mortality

The area covered and the dead deer found each year in the trend yards are summarized according to cause of death in Table 3, together with the number of critical snow days. The available data for the years prior to 1962 are included. Although the surveys in these yards were meant to be comparable from year to year, the amount of area surveyed was not the same every year. This lack of consistency lessened the comparability of the annual records, even on a dead deer per square mile basis, because nonrandom surveys are representative only of the area covered. If a survey included a major concentration area of a given yard one year but excluded it during a shorter survey the next year, the results would not be comparable. Likewise, wholly excluding a yard in one year could seriously bias comparisons, depending on the number of deer using that yard.

In spite of the lack of consistency in the amount of area surveyed from year to year, winter losses per square mile in the trend yards were consistent with the relative severity of the winter. There was a significant correlation ($r = 0.821$, $P < 0.01$) between starvation losses (SL) and the number of critical snow days (X). The regression is described by the following equation

$$SL \pm 2.10 = -0.29 + 0.098X$$

Other winter losses (OL) were also correlated ($r = 0.797$, $P < 0.01$) with the number of critical snow days. The regression equation was

$$OL = 0.99 + 0.050X$$

This is reasonable because it is probable that many losses from undetermined causes were actually deaths from starvation and because animals

TABLE 3. FREQUENCY OF DEAD DEER RECORDED DURING STRIP SURVEYS IN TREND YARDS IN THE ADIRONDACK REGION FROM 1944 TO 1970, ACCORDING TO CAUSE OF DEATH AND NUMBER OF CRITICAL SNOW DAYS

Year*	Area surveyed (square miles)	Dead deer per square mile			Critical snow days§
		Starvation	Other causes	Total	
1944	†	. .	. .	19.1	. .
1945	†	. .	. .	8.5	. .
1946	†	. .	. .	3.0	. .
1947	†	. .	. .	5.2	. .
1948	†	. .	. .	15.0	. .
1949	†	. .	. .	1.0	. .
1950	†	. .	. .	1.0	. .
1951	†	. .	. .	1.0	. .
1952	†	6.81	1.01	7.82	. .
1953	9.1	0.22	1.76	1.98	. .
1954	†	4.40	2.20	6.60	. .
1955	18.6	6.81	5.42	12.23	58
1956	†	2.20	3.30	5.50	55
1957	†	‡	‡	1.00	7
1958	15.9	6.90	4.60	11.50	48
1959	20.1	8.80	4.42	13.22	81
1960	17.2	11.93	4.13	16.06	82
1961	13.2	0.98	1.36	2.34	25
1962	15.7	5.49	3.70	9.19	47
1963	17.7	3.33	3.37	6.70	76
1964	12.2	2.31	1.90	4.21	38
1965	6.7	0.60	2.23	2.83	17
1966	8.4	2.97	2.48	5.45	23
1967	9.4	1.60	2.35	3.95	24
1968	8.8	3.51	3.51	7.02	25
1969	5.8	7.06	7.92	14.98	94
1970	5.9	9.55	5.12	14.97	103

*Represents spring of each overwinter season.

§Average number of days with 20 or more inches of accumulated snow according to combined records for U.S. Weather Service stations at Booneville, Lake Placid, Newcomb, Old Forge, Speculator and Wanakena.

†Data available in files of Project W-89-R did not give area surveys, only total dead deer per square mile.

‡Negligible.

weakened by crippling or being harassed by predators are especially likely to succumb during severe winters. The total mortality (TL) in these yards was correlated ($r = 0.866$, $P < 0.01$) with the number of critical snow days (Figure 1). The regression equation was

$$TL \pm 2.62 = 0.70 + 0.147X$$

The records for the Moose River plains from 1965 to 1970 are summarized in Table 4. There was no correlation between the deer mortality in this area and that in the trend yards or the number of critical snow days in the Adirondacks generally as given in Table 3. A major reason may have been the presence of a large number of bears. The survey in this area was usually one of the last to be made each year (May), and deer carrion was heavily used by bears each spring. Carcasses were torn apart and scattered, making it impossible to determine the cause of death in many cases and undoubtedly causing some to be missed.

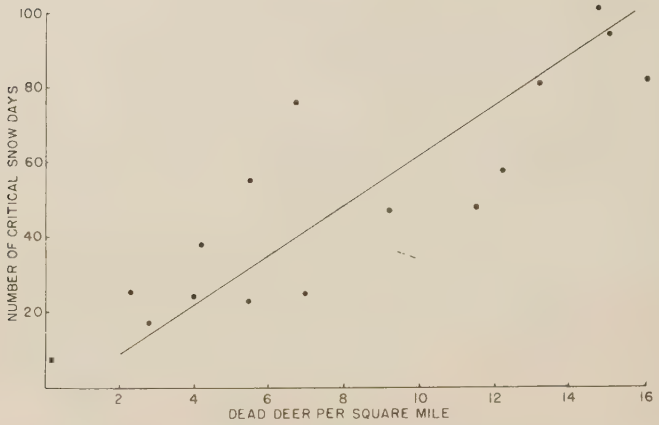

Figure 1. Relationship between the total winter mortality of deer (as dead deer per square mile) and the number of critical snow days, for the Adirondack trend yards, 1955-1970.

TABLE 4. FREQUENCY OF DEAD DEER RECORDED DURING STRIP SURVEYS ALONG RANDOM LINES IN THE MOOSE RIVER YARDING AREA FROM 1965 TO 1970 AND IN THE LORDVILLE YARDING AREA FROM 1961 TO 1970, ACCORDING TO CAUSE OF DEATH AND NUMBER OF CRITICAL SNOW DAYS

Year*	Dead deer per square mile			Critical snow days§
	Starvation	Other causes	Total	
	Moose River area			
1965	0.00	9.7	9.7	17
1966	0.00	14.2	14.2	23
1967	0.00	6.86	6.86	24
1968	1.48	1.48	2.96	25
1969	5.63	5.63	11.26	94
1970	17.50	12.50	30.00	103
	Lordville area			
1961	27.20	3.41	30.61	16
1962	18.72	2.53	21.25	0
1963	48.13	3.52	51.65	10
1964	15.20	3.41	18.61	4
1965	0.88	0.88	1.76	0
1966	0.88	0.88	1.76	1
1967	6.83	2.53	9.36	6
1968	0.00	4.27	4.27	0
1969	†	†	. .	0
1970	36.03	0.00	36.03	12

*Represents spring of each overwinter season.

§Average number of days with 20 or more inches of accumulated snow according to the U.S. Weather Service stations as noted in Table 3 for the Moose River area and the station at Fishs Eddy for the Lordville area.

†No data.

The records for the Lordville yard are also summarized in Table 4, together with the number of critical snow days. Deer mortality and the

snow depth at the Fishs Eddy weather station were correlated ($r = 0.704$, $P = 0.05$). However, the degree of mortality was more highly correlated ($r = 0.883$, $P < 0.01$) with the snow depth records for the Adirondacks.

STARVATION VERSUS OTHER LOSSES

Losses in both the trend and non-trend yards in the Adirondacks from 1962 to 1970 are compared with respect to cause of death in Table 5. The ratio of deaths from starvation to other losses was 1.1 : 1 in the trend yards and 1.2 : 1 elsewhere. Differences in the ratio from year to year were not related to winter severity, and the correlation indicated a consistent relationship whether the winter was mild or severe.

For the losses from starvation, the preponderance of the carcasses that could be aged were fawns, i.e., 79 per cent in the trend yards and 82 per cent in the non-trend yards. The proportion that were fawns was inversely correlated ($r = -0.721$, $P = 0.05$) with winter severity because as the winters became more severe such losses included more adults, especially females.

For losses from other causes, the ratio of fawns to adults was essentially even. This still represented a heavier relative mortality among fawns because, in the Adirondacks, there were fewer fawns than adult deer going into the winter. Among adult deer, losses of females were greater than those of males, in part because in this region legal hunting during the fall removed up to 35 per cent of the male population.

Totals from both the trend and non-trend yards indicated that losses were greater among females than males, whether death was from starvation or other causes. For the carcasses where sex could be identified (fawns and adults combined), 59 per cent were females.

DISCUSSION

The strip surveys made provided data indicating that variations from year to year in winter mortality of deer were correlated with the number of days when snow depths of 20 inches or more were present. However, such surveys are representative only of the strips surveyed because, particularly in areas where the winter climate is severe, deer are not randomly distributed over their range during the winter, but are concentrated in yarding areas. For this reason, dead deer per square mile on either strip surveys or random survey lines cannot be expanded to estimate the total winter mortality of the deer population throughout a range area. Thus, such surveys do not provide data that can be used to derive mortality and population estimates on which to base hunting regulations. Nevertheless, they can be used to demonstrate to the public the winter losses that occur and their relation to the condition of the range, and to emphasize the need for management measures, e.g., taking antlerless deer, to maintain deer populations in balance with natural forage production.

TABLE 5. COMPARATIVE LOSSES OF DEER FROM STARVATION AND OTHER CAUSES, ACCORDING TO SEX AND AGE, IN BOTH TREND AND NON-TREND YARDS IN THE ADIRONDACK REGION FROM 1962 TO 1970 IN TERMS OF THE NUMBER RECORDED DURING STRIP SURVEYS

	Starvation								Other causes							
	Fawn			Adult			Unknown sex and age	Total		Fawn			Adult		Unknown sex and age	Total
Year*	Male	Female	Unknown sex	Male	Female	Unknown sex			Male	Female	Unknown sex	Male	Female	Unknown sex		
Trend yards																
1962	31	28	10	2	8	1	6	86	6	5	18	4	16	6	3	58
1963	17	24	6	3	3	0	6	59	2	9	14	5	12	9	7	58
1964	10	7	4	4	2	1	0	28	1	5	2	1	7	1	6	23
1965	0	3	1	0	0	0	0	4	1	1	3	3	4	1	2	15
1966	7	12	2	0	1	1	2	25	4	3	1	3	3	1	13	28
1967	4	4	3	1	2	1	0	15	0	1	1	1	6	4	9	22
1968	13	12	2	1	3	0	0	31	3	7	3	4	4	1	9	31
1969	4	10	6	4	10	1	6	41	2	1	7	0	5	3	26	44
1970	17	8	12	6	11	1	1	56	1	4	1	2	5	1	16	30
Sub-total	103	108	46	21	40	6	21	345	20	36	50	23	62	27	91	309
Non trend yards																
1962	18	23	1	2	5	0	0	49	5	1	3	1	5	2	1	18
1963	14	17	6	2	1	0	0	40	1	0	1	0	3	3	3	11
1964	8	8	1	0	0	0	0	17	2	5	3	1	4	0	0	15
1965	0	1	0	0	2	0	0	3	3	1	0	1	1	0	0	6
1966	4	1	0	0	0	2	0	7	1	2	1	1	2	0	3	10
1967	0	0	0	1	1	0	0	2	1	1	0	1	2	1	4	10
1968	11	6	1	1	1	1	0	21	1	3	5	1	6	0	9	25
1969	12	19	2	0	8	0	0	41	8	4	2	2	17	0	9	42
1970	10	6	6	4	7	0	0	33	2	3	5	1	4	1	23	39
Sub-total	77	81	17	10	25	3	0	213	24	20	20	9	44	7	52	176
Total	180	189	63	31	65	9	21	558	44	56	70	32	106	34	143	485

*Represents spring of each overwinter season.

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THE MUSKELLUNGE FISHERY IN THE UPPER NIAGARA RIVER[1]

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ABSTRACT

Annual and semimonthly harvest statistics for muskellunge in the upper Niagara River are presented for most years from 1968 through 1977. Except for 1976, the annual average weight of fish captured during the period 1971-1977 was between 4.3 and 4.7 kilograms. The 1976 catch contained an exceptional number of smaller, 3-year-old fish. Muskellunge generally reached legal length and entered the fishery during their fourth year when males were maturing sexually and females were still immature. Most angling effort was expended on about 20 per cent of the river area.

Several populations of muskellunge (*Esox masquinongy*) are known to exist in the Laurentian Great Lakes and their interconnecting waterbodies. Results of studies on some of these populations have been reported by Krumholz (1949) for Lake St. Clair, by Williams (1948) for waters bordering Michigan, by Buss and Miller (1961) for eastern Lake Erie and by Hourston (1952) for the St. Lawrence region.

Newspaper archives suggest that muskellunge of the upper Niagara River (Figure 1) have constituted a popular local fishery at least since the 1850's. Despite this popularity, the Niagara River population had received little attention from fishery managers and researchers before 1960. A few attempts were made to augment the population by stocking (Greeley, 1929; Craig, 1976; R. H. Griffiths of the State Department of Environmental Conservation, personal communication, 1977), but the outcome of these attempts was never determined. Because the stocking efforts were intermittant, the present population is primarily a natural one.

Between 1960 and 1972, the State Department (unpublished data) examined approximately 160 muskellunge of various sizes obtained from the Niagara River by trap nets, seines, electrofishing and creel surveys. Of those fish, 67 were marked and released. Additional data were recorded during a study by the Ontario Ministry of Natural Resources (Craig, 1976). The Ministry's data included some age determinations.

During 1975 and 1976 the authors conducted an extensive study of muskellunge in the Niagara River (Harrison, 1978) that encompassed many of the life-history parameters of the species and examined the

[1]This paper is derived from the senior author's Ph.D. thesis submitted to the State University of New York at Buffalo where the junior author was Assistant Professor of Biology. The authors thank Alex Drew for making available muskellunge catch data, and the owner and employees of Hank's Boat Livery for their cooperation. The study was supported by New York Sea Grant.

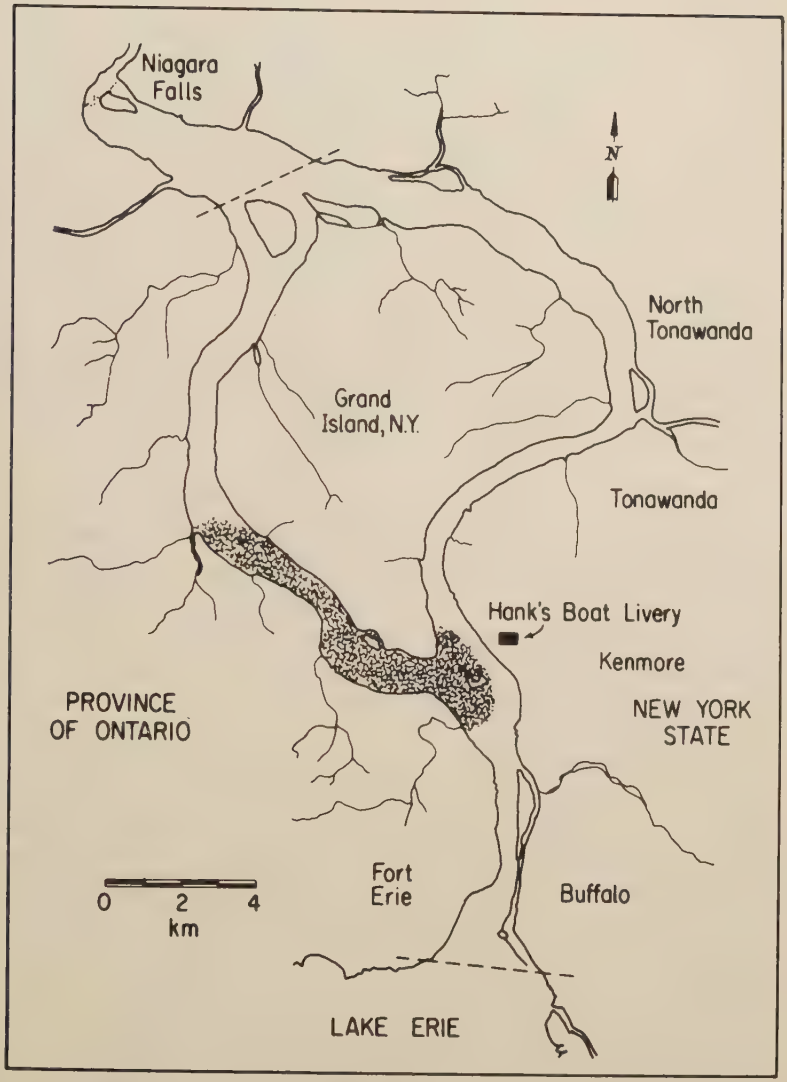

Figure 1. Map of the upper Niagara River showing limits of the study area (dash lines) and the area most heavily fished for muskellunge (stippled).

muskellunge fishery. The portion of the study pertaining to angler harvest is reported here.

METHODS

Data were collected on 312 muskellunge from the upper Niagara River by means of trap nets (15), seines (47), electrofishing (72) and creel surveys at boat liveries and marinas (178) during 1975 and 1976. Collections began

in early spring and continued until the angling season ended (November 30). The data recorded included total length, weight, sex and capture location. Live fish longer than 40 centimeters were marked with addressed, individually numbered dart tags and released. Radio announcements, newspaper articles, and signs posted at liveries, marinas, sporting goods stores, etc. advertised the tagging study. Fish were aged from dry-mounted scales at 40X magnification. For fish collected in the spring, an annulus was assumed at the scale margin. Cleithra samples were also taken from 110 creeled fish and were used as a crosscheck for scale aging (Harrison and Hadley, 1979a). In addition, data on 2,654 fish taken between 1968 and 1977 (1970 data were not available) were obtained from records kept at Hank's Boat Livery where each angler-captured fish returned to the livery was recorded by date of capture. After 1971 the weight of each fish (measured in pounds on a Chatillon type 4200 scale) was also recorded.

RESULTS AND DISCUSSION

Although muskellunge inhabited much of the upper Niagara River, most angling effort was expended on a 1,000-hectare portion (Figure 1) representing about 20 per cent of the total surface area of the upper river. The reason for the concentration of effort in this sector is not clear, but proximity to launching and docking facilities, distance from Niagara Falls, use the the Tonawanda Channel by the shipping industry, and tradition may have been factors.

In 1975 three of 10 legal-sized (71 centimeters in total length) fish, which had been tagged prior to the angling season, were recaptured by anglers in the more heavily fished portion of the river. In 1976, between April 23 and June 30 (the twelfth day of the angling season), an additional 38 legal-sized fish and 16 sublegal fish were tagged in the angled area. Data on average growth (Harrison and Hadley, 1979b) suggest that 10 of the sublegal fish were large enough to have reached legal size during the 1976 angling season. During that season, anglers recaptured four of the larger fish and one smaller individual which had grown to legal length. Two fish tagged in 1976 were recaptured by anglers in 1977. Seven of the 10 marked fish recaptured by angling in 1975, 1976 and 1977 were taken by anglers fishing out of Hank's Boat Livery. This tag-return ratio tended to support the local contention that this livery was the place where the majority of the muskellunge catch was returned. Craig (1976) made frequent visits to this livery in his study for the Ontario Ministry of Natural Resources and advocated its use as a source of management data. The authors' recapture data were too few to permit reliable determination of exploitation rate and population size, but they suggest that the level of exploitation may have been between 10 per cent (based on 1976 data) and 30 per cent (1975 data).

Angler catch data obtained from Hank's Boat Livery were used to derive

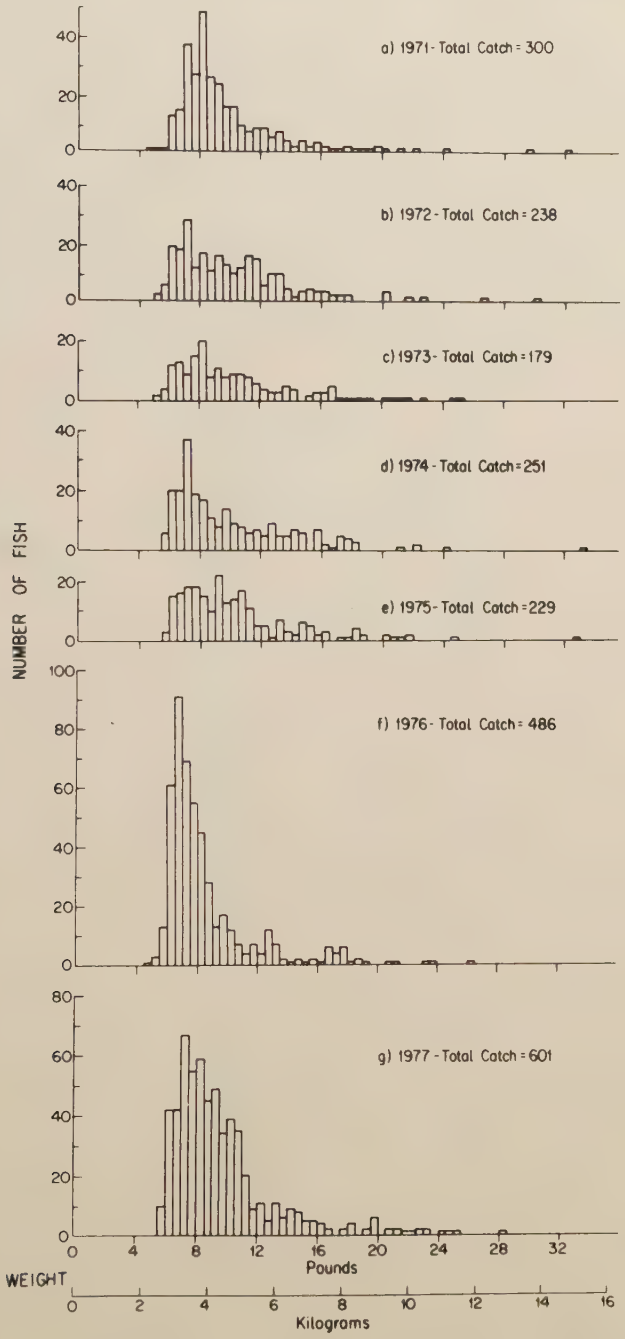
a) 1971 - Total Catch = 300
b) 1972 - Total Catch = 238
c) 1973 - Total Catch = 179
d) 1974 - Total Catch = 251
e) 1975 - Total Catch = 229
f) 1976 - Total Catch = 486
g) 1977 - Total Catch = 601
NUMBER OF FISH
WEIGHT
Pounds
Kilograms

Figure 2. Histograms showing weight of the annual catch of muskellunge in the Niagara River by anglers from Hank's Boat Livery. Data are plotted in pounds, but kilogram scale is provided for conversion.

Table 1. Average Weight of Muskellunge Taken in the Upper Niagara River, According to Month and Year*

Year	June	July	August	September	October	November	Annual
1971	4.36 (30)	3.91 (95)	4.34 (80)	4.49 (55)	5.31 (38)	3.18 (2)	4.44 (300)
1972	5.47 (22)	4.06 (56)	4.19 (85)	4.49 (29)	5.29 (29)	5.66 (17)	4.61 (238)
1973	5.64 (22)	4.29 (64)	4.04 (45)	4.93 (20)	5.40 (23)	6.50 (5)	4.72 (179)
1974	4.55 (9)	4.64 (62)	3.99 (77)	4.88 (33)	4.39 (39)	5.16 (31)	4.51 (251)
1975	4.56 (21)	4.59 (87)	4.48 (51)	4.68 (31)	4.82 (28)	5.08 (11)	4.63 (229)
1976	3.49 (36)	3.72 (179)	3.74 (108)	3.86 (96)	4.25 (67)	. . (0)	3.90 (486)
1977	4.21 (97)	4.11 (265)	4.29 (136)	4.73 (61)	5.48 (33)	5.10 (9)	4.32 (601)
Total	4.41 (237)	4.10 (808)	4.14 (582)	4.43 (325)	4.87 (257)	5.29 (75)	4.36 (2,284)

*All data from specimens returned to Hank's Boat Livery. Weights in kilograms; figures in parentheses are number of specimens.

weight histograms for each year from 1971 to 1977 (Figure 2). Large fluctuations in year-class strength are evident in these histograms. Age-weight data (Harrison and Hadley, 1979b) indicated that these fluctuations had the greatest effect on the abundance of 3-year-old and 4-year-old fish in the catches. Annual and monthly average weights of harvested fish were derived from livery records and are listed in Table 1. The annual average weights for 1971-1975 were within the 95 per cent confidence interval for fish with an average age of 5 + years (4.09 to 4.85 kilograms), but the data for 1976 indicated an average of 4 + years. The lower average age in 1976 resulted from an exceptional number of 3-year-old fish (1973 year class) in the catch. By 1977 members of this year class were 4 years old, and the average weight (and age) of the catch increased accordingly.

Body lengths at the time of formation of the third annulus were back-calculated from the cleithra of 65 fish taken as 3 year olds in 1976. These data show that 55 per cent of the harvested 3-year-old fish were of sublegal length in late May when annual growth began but grew to legal size during the angling season, and seasonal growth data suggest that recruitment of these fish was nearly complete by mid-August (Harrison and Hadley, 1979b). A decline in the monthly average weight of captured fish during the early part of the angling season (Table 1) followed by a steady increase in average weight could be explained by this recruitment pattern. The slightly anomalous pattern in 1976 probably resulted from the exceptional abundance of 3-year-old fish (1973 year class). The extreme abundance of this year class was first suggested during the 1975 angling season when anglers hooked and released an extraordinary number of sublegal fish. Reasons for the success of this year class are not known.

Semimonthly catch totals and average water temperatures for the 1968 through 1977 angling seasons are shown in Figure 3. Catch totals are presented as numbers of fish landed for each period and as percentage of the total number caught in that season. The first period for each month has 15 days, while the second period has 15 days for September and November, but 16 days for July, August and October. The length of the June period depends on the opening date of the angling season and varies from 10 to 16 days. For most years, the catch appears to have been greatest when water temperatures were highest and to have diminished as water temperature fell. However, the data are not sufficient to determine the relative importance of greater angling effort during summer months and increased catchability of the fish at higher water temperature. The data do suggest that researchers interested in examining creeled fish should be most active during the first half of the angling season.

Due to sexually dimorphic growth (Harrison and Hadley, 1979b), females reached legal size at a younger age than males and were harvested more heavily. The sex ratio of the combined 1975 and 1976 harvest was 1.63 females per male.

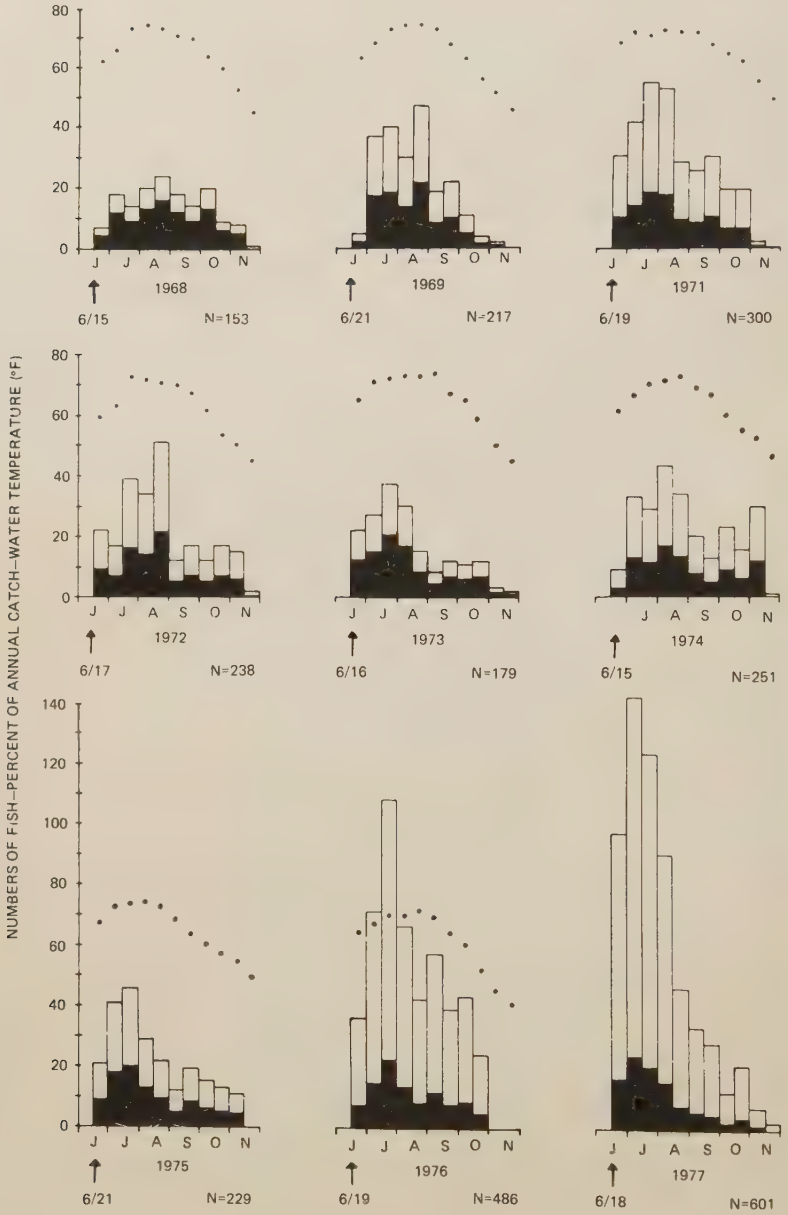

Figure 3. Number of muskellunge captured (open histograms), percentage of annual muskellunge catch (shaded histograms) and average water temperature (heavy dots) for semimonthly periods from June to November for the years 1968 to 1977. The same vertical scale serves all three variables. Catch data for 1970 and water temperature data for 1977 were not available. The total annual catch (N) and the opening date of each angling season are shown below the histograms. The season ended on November 30 each year.

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INTEREST IN WILDLIFE MANAGEMENT AMONG STATE FORESTERS IN NEW YORK: OPPORTUNITIES FOR COOPERATION[1]

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ABSTRACT

As owners of private nonindustrial forestland increasingly look to these lands for sources of fuel and timber revenues, the need to ensure that they understand the wildlife management implications of their forest management activities increases. State foresters working directly with private owners have tremendous potential for positively influencing the wildlife management practised. A survey of State foresters in New York showed that these land management specialists have extensive interest in enhancing wildlife values on private forestlands and would like more information and education to help them improve their wildlife management expertise. Although foresters seldom seek assistance from wildlife biologists, their interest in wildlife and receptivity to wildlife information indicate that wildlife biologists have an opportunity to help foresters reach higher levels of expertise and thus increase the quality of wildlife habitat on private forestlands in New York.

There is growing evidence that for many Americans wildlife has become a household concern, whether valued for economic, social or ecological reasons. This is evident in the increased numbers of wildlife-oriented organizations and increased membership in many existing organizations (Witter, 1977). Current predictions suggest a continuing increase in both consumptive and nonconsumptive uses of wildlife (U.S. Department of Agriculture, 1980). Concurrently, the need to supply forest products for an expanding human population (the U.S. Forest Service predicts that the demand for wood and wood products will double by the year 2020) will cause pressures that could degrade more and more forest wildlife habitat. Without timely and effective intervention, the demand for wildlife may eventually outstrip the available supply. Significant progress toward avoiding such an undesirable situation could be achieved by developing a greater stewardship of forest wildlife resources among those people exercising the greatest influence over them—private forestland owners.[2]

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[1]This study was made by the Department of Natural Resources at Cornell University in cooperation with the Northeastern Area Office of State and Private Forestry of the U.S. Forest Service which also furnished funds. The authors wish to thank the staff of the Division of Lands and Forests of the New York State Department of Environmental Conservation, especially the State foresters who responded to the survey, for their cooperation.

[2]This paper deals wholly with private nonindustrial forestlands unless otherwise noted.

The future abundance and diversity of wildlife will be determined largely by the nature and extent of the management of the land upon which the various species depend. Most of this wildlife habitat is privately owned, especially in the Northeast[3] where 89 per cent of the total land area was in such ownership in 1969 (Moyer and Dougherty, 1976). Thus, opportunities to influence wildlife habitat are largely controlled by these landowners. Fortunately for wildlife, forested acreage in the Northeast has been increasing in recent decades (Ferguson and Mayer, 1970). The forestlands of states like New York constitute a multimillion dollar timber resource that could provide a major economic benefit if they were managed to full potential (Forest Industries Council, 1979).

As people look to domestic sources of energy and energy-saving technology, private forests will play an increasingly important role in supplying fuelwood and energy-efficient raw materials. In New York 86 per cent (or 13.4 million acres) of all commercial forestland (58 per cent of the State's land area) was classified as being in private, nonindustrial ownership in 1970, but only 1 per cent was estimated as being managed each year (Forest Industries Council, 1979) by the approximately 190,000 private forest owners in New York (Canham, 1980).

The interest of private owners in fuelwood has mushroomed to the point where it can be considered a primary incentive for management. But landowners still are concerned with the wildlife resources on their forestlands. Wildlife values have long been recognized and commented upon by forest economists such as Clawson (1975, 1979), and attempts have been made to determine the relative importance of wildlife to these owners. It has become clear that the consequences of these wildlife interests on effective management are significant. For example, Canham (1981) reported that, as an ownership objective, recreational use (including wildlife interests) extended over a majority (58 per cent) of private forestland in New York. He also reported that a fear of destroying wildlife habitat ranked third statewide as a reason given by private owners for not wanting to harvest timber. Thus, in New York, owners of 2 million or more acres of private, nonindustrial forestland feel that the wildlife habitat on their lands would be seriously impaired if logging were permitted and therefore do not effectively manage their forests (Canham, 1981).

State and federal forest management and wildlife management agencies, natural resources extension specialists and private wildlife-oriented organizations are cognizant of these multiple-use needs of private landowners in New York and recognize the necessity for improving efforts to integrate wildlife concerns in forest management planning for private landowners. This concern is evident in a recent report on the forest resources of

[3]The region referred to constitutes the states of Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, Vermont, Virginia and West Virginia.

New York (Brooks, 1981) which listed forest wildlife as a major issue. The report cited the reluctance of many private owners to undertake forest management for fear of harming wildlife and encouraged efforts to allay such fears. It also suggested that lack of communication between wildlife biologists and foresters is an impediment to the integration of wildlife considerations in forest management. This forester/wildlife biologist schism has been examined previously in New York (Decker, 1976), but a recent study of the interest of State foresters (i.e., employed by the State Department of Environmental Conservation) in wildlife indicates that this condition might be remedied if better communication and cooperation were sought mutually. Given the influence that these foresters have on the management of private forests, their current and potential importance in promoting wildlife habitat improvement is obvious. It is the authors' opinion that wildlife biologists in New York can be of assistance to State foresters in their efforts to understand the wildlife aspects of management plans they develop for private forests. The information presented here identifies some opportunities for cooperation.

METHODS

A self-administered, mail-back questionnaire was developed and reviewed by wildlife and forestry extension specialists. The questionnaire was pretested at a wildlife and forestry training session for state-service foresters from Connecticut, Massachusetts and Rhode Island, after which it was revised. In October 1981, questionnaires were distributed by the Northeastern Area Office of State and Private Forestry of the U.S. Forest Service to state foresters throughout the 20-state northeastern region. Completed questionnaires were returned to that office and then forwarded to the project staff at Cornell University where responses were coded, keypunched and analyzed using the Statistical Package for the Social Sciences computer program (Nie et al., 1975). Although the study was conducted regionwide (Decker et al., 1982), only New York data are considered here.

RESULTS

The over-all response rate for the northeastern region was 83 per cent, with the rates for individual states ranging from 50 to 100 per cent. The rate for New York was 67 per cent and represented a sample of 40 that constituted two-thirds of the State foresters working with private owners in this State.[4]

Profile of State Foresters

The respondents (mean age = 38 years) reported a mean of 12 years of

[4]To facilitate comparison, the data are given as rounded percentages.

professional experience. Most (95 per cent) held a B.A. or B.S. degree in forestry, and 90 per cent had completed some coursework in wildlife ecology/management. About half (48 per cent) of the respondents had taken one or two wildlife courses, 39 per cent had had three or four courses, and 13 per cent had had five or more. Over three-fourths (78 per cent) had attended a wildlife management in-service training session during their professional career, which for the majority (52 per cent) consisted of only one or two sessions.

The respondents indicated considerable interest in wildlife and in their role in wildlife management on private forests (Table 1). In comparing themselves with their peers, a majority (58 per cent) believed that they were about average in both their level of expertise in wildlife management and their training in wildlife management. All the respondents rated their interest in wildlife management as average or above average. Nearly all (92 per cent) considered themselves average or above average in the importance they placed on integrating wildlife concerns in private forestland management, as well as on their own in-service training in wildlife management.

A general personal interest in wildlife was reflected by the fact that the majority of respondents reported participating regularly in some form of outdoor recreation, fishing being the most popular (77 per cent), followed by hunting (62 per cent), boating/canoeing (60 per cent), hiking (59 per cent) and camping (54 per cent). Despite this expression of interest in wildlife, only 38 per cent felt that an appropriate part of their role in the management of private forests was to encourage an awareness and enhancement of wildlife. About half (54 per cent) stressed general forestland

TABLE 1. STATE FORESTERS' SELF-EVALUATION OF THEIR INTEREST AND EXPERTISE IN WILDLIFE MANAGEMENT, COMPARED WITH THAT OF THEIR PEERS

Interest and expertise	Number*	Evaluation (per cent)				
		Above average	About average	Below average	None	Total
Interest in wildlife management	40	52.5	47.5	00.0	00.0	100.0
Importance placed on integrating wildlife concerns in forest management	40	30.0	62.5	7.5	00.0	100.0
Importance of in-service training in wildlife management	40	30.0	62.5	7.5	00.0	100.0
Level of field experience in wildlife management	40	17.5	57.5	25.0	00.0	100.0
Level of formal training in wildlife management	40	17.5	57.5	25.0	00.0	100.0

*Usable responses.

Table 2. Frequency of Recommendation By State Foresters With Respect to Various Wildlife Management Considerations*

Consideration	Number§	Frequency (per cent)				
		Always	Often	Seldom	Never	Total
Preventing livestock grazing in woodlots	40	75.0	17.5	5.0	2.5	100.0
Woodsroad construction to prevent erosion and protect stream water quality	40	72.5	25.0	0.0	2.5	100.0
Preserving forested buffer strips along streams in a timber cut	40	60.0	30.0	5.0	5.0	100.0
Preserving den trees	40	17.5	75.0	7.5	0.0	100.0
Preserving or releasing wild apple trees	40	22.5	42.5	32.5	2.5	100.0
Preserving conifer cover in deer wintering areas	32	18.7	50.0	21.9	9.4	100.0
Creating small openings in dense forest	40	7.5	67.5	22.5	2.5	100.0
Creating species and age diversity by scheduling frequent partial cuts instead of one large one	39	10.3	53.8	28.2	7.7	100.0
Preserving hedgerows and vegetation in "odd" areas (e.g., ditches)	39	12.8	41.0	33.4	12.8	100.0
Preserving existing or potential mast-producing wolf trees	40	7.5	45.0	37.5	10.0	100.0
Seeding logging roads, landings and clearings	40	7.5	37.5	42.5	12.5	100.0
Creating or maintaining grassy or brushy clearings	39	5.1	43.6	35.9	15.4	100.0
Preserving tree cavities	38	2.6	47.4	39.5	10.5	100.0
Making clearcuts small and irregularly shaped	34	11.7	32.4	32.4	23.5	100.0
Preserving or creating snags	40	2.5	30.0	50.0	17.5	100.0
Constructing brushpiles from slash	39	5.2	28.2	41.0	25.6	100.0
Curring back trees along logging roads to create "edge"	39	2.6	20.5	61.5	15.4	100.0
Planting shrub borders	39	0.0	30.8	51.3	17.9	100.0
Planting food plots and food strips	39	0.0	28.2	46.2	25.6	100.0
Preserving and managing vegetation around old homesites	37	2.7	24.3	32.4	40.6	100.0
Creating "living" brushpiles	38	0.0	21.1	36.8	42.1	100.0
Constructing and placing nest boxes for birds	38	0.0	13.2	34.2	52.6	100.0
Creating waterholes for wildlife	36	0.0	8.3	41.7	50.0	100.0
Constructing and placing nest boxes for mammals	37	0.0	2.7	18.9	78.4	100.0

*In order of descending frequency.

§Usable responses.

management as their policy toward wildlife management rather than giving wildlife specific emphasis, and 18 per cent simply referred questions from landowners concerning wildlife to wildlife biologists rather than addressing such questions themselves.

WILDLIFE MANAGEMENT PRACTICES RECOMMENDED TO PRIVATE FOREST OWNERS

Generally, interest in the effect of forest management on wildlife is high among foresters, and most encourage private forest owners to undertake some wildlife management practices. Apparently, State foresters in New York recommend a wide range of such practices. Those recommended most frequently being to prevent livestock grazing in woodlots, to construct woodsroads properly and to preserve buffer strips along streams (Table 2). Many other practices were recommended "always" or "often" by a majority of the respondents. However, a few practices primarily benefitting wildlife which involved some expenditure by forest owners were recommended infrequently. These included placing nest boxes for mammals, erecting birdhouses and creating wildlife water holes.

The respondents indicated being generally aware of the effects that common silvicultural practices may have on wildlife. Most reported that, based on their observations, both timber harvesting and tree planting had a positive influence on wildlife, while about 15 per cent believed that these practices had a mixed influence. Two-thirds indicated that timber stand improvement work had a positive influence.

FORESTERS' NEEDS FOR INFORMATION CONCERNING WILDLIFE MANAGEMENT

From their answers to five questions, it was apparent that the foresters would like to learn more about wildlife management. They indicated that their needs could be met through printed material, help from wildlife biologists either in the field or during in-service training sessions or through a combination of these. Subject matter covering the technical aspects of wildlife management was more desired than general conceptual information.

State foresters in New York seldom seek the assistance of the various wildlife experts available to them. The respondents indicated that State wildlife agency biologists were consulted most often, but even they were consulted "regularly" by only about a fifth of the foresters and "sometimes" by 38 per cent (Table 3). The other specialists cited were consulted by only one-quarter or fewer of the foresters, and then infrequently.

Preferences of the respondents for the content and coverage of in-service training and the type of training desired are summarized in Table 4. Training programs dealing with wildlife management techniques and with

Table 3. Frequency With Which State Foresters Consult Various Wildlife Specialists When Formulating Wildlife Management Recommendations

Consultant	Frequency (per cent)				
	Regularly	Sometimes	Seldom	Never	Total
Wildlife biologist of State agency	20.0	37.5	25.0	17.5	100.0
Wildlife specialist of State and Private Forestry Office of U.S. Forest Service	2.5	7.5	17.5	72.5	100.0
Wildlife specialist of Cooperative Extension organization	0.0	7.5	15.0	77.5	100.0
Wildlife biologist of U.S. Soil Conservation Service	0.0	7.5	12.5	80.0	100.0
Biologist of U.S. Fish and Wildlife Service	0.0	0.0	15.0	85.0	100.0
Private wildlife consultant	0.0	2.5	5.0	92.5	100.0

the habitat requirements of particular species were the subjects ranked highest. Classroom instruction and field demonstration were the types of training most desired. Approximately one-fourth (26 per cent) of the respondents indicated that they would prefer to have formal wildlife in-service training sessions once a year, while 37 per cent reported that once every two years would be sufficient. However, 21 per cent wanted sessions only once every five years, while 16 per cent wanted them twice a year.

Most State foresters placed a high priority on the development of a comprehensive extension-type bulletin dealing with wildlife management practices and techniques that they could show or give to forest owners. Leaflets and circulars on individual practices were also highly desired, as well as fact sheets on individual species. A slide/tape "how-to" series on wildlife management practices, bulletins on wildlife species and leaflets on wildlife management principles were assigned moderate to high priority for development.

State foresters felt that sociological research dealing with the attitudes of forest owners would be of little help to them in working with these people. However, 30 per cent wanted research to investigate the effects of silvicultural practices on wildlife, and 23 per cent were interested in research on the habitat requirements of various forest wildlife species. Only 13 per cent stated that no more research of this type was necessary.

Foresters' Perceptions of the Wildlife Interests and Needs of Landowners

According to the respondents, private forest owners have considerable interest in the enhancement of their forestlands for wildlife, but knowledge

Table 4. Preference of State Foresters With Respect to Content and Type of In-service Training

Subject or method	Preference (per cent)				
	Highly preferred	Moderately preferred	Least preferred	No interest	Total
Content of training					
Wildlife management techniques and practices	69.2	23.1	5.1	2.6	100.0
Habitat requirements of particular species or species groups	56.3	38.5	2.6	2.6	100.0
Wildlife management principles	38.5	48.7	10.3	2.5	100.0
Wildlife ecology concepts	12.8	61.5	23.1	2.6	100.0
Wildlife resource (habitat and species) inventory	7.9	42.1	36.8	13.2	100.0
Type of training					
Workshop					
Classroom instruction and field demonstration	74.3	20.5	2.6	2.6	100.0
Field demonstration	52.6	42.2	2.6	2.6	100.0
Classroom instruction and discussion	2.6	38.5	56.3	2.6	100.0
Regularly published material					
Leaflets and circulars on specific topics	26.3	50.0	21.1	2.6	100.0
Wildlife newsletter	15.4	48.7	30.8	5.1	100.0
Mail or telephone correspondence course	7.7	15.4	43.6	33.3	100.0
Video-tape course	5.6	36.1	44.4	13.9	100.0

barriers and economic problems often must be resolved before desirable practices can be implemented. Much of the current interest lies in big game mammals and in attracting the particular kinds of animals desired by various owners. Some owners are interested in developing and using consumptive recreation skills, while wildlife identification and appreciation are the main interests of others.

All respondents reported having recently worked with forest owners who expressed some degree of interest in wildlife on their land. Three-fourths indicated that 76 to 100 per cent of the owners who were interested in wildlife on their land were also interested in timber production. Almost half (45 per cent) felt that over the previous 5 to 10 years the percentage of owners who expressed an interest in wildlife had remained the same, while 35 per cent believed it had increased and 50 per cent expected it to continue to increase. A notable minority (30 per cent), however, were of the opinion that the interest of forest owners in wildlife would remain at about the current level.

In the experience of the respondents, the various game species are the types of wildlife for which forest owners express the most interest, although considerable interest was also indicated for songbirds (Table 5). The State foresters reported that, when planning or carrying on forest management activities, about half the owners they had worked with expressed an interest in attracting particular kinds of wildlife and that a quarter of them were concerned about the destruction of habitat.

Private forest owners were believed to have considerable interest in acquiring knowledge about wildlife identification and appreciation, and in developing and using consumptive recreational skills. About half the foresters believed that forest owners have at least a moderate level of interest in learning about wildlife management techniques. But they felt there is

Table 5. Relative Interest of Private Owners of Nonindustrial Forestlands in Selected Types of Wildlife As Reported By State Foresters

Type of wildlife	Number*	Relative interest (per cent)§					
		High	Medium	Low	None	Not applicable	Total
Big game mammals	40	85.0	12.5	2.5	0.0	0.0	100.0
Upland game birds	40	32.5	52.5	15.0	0.0	0.0	100.0
Small game mammals	40	20.0	65.0	15.0	0.0	0.0	100.0
Songbirds	40	17.5	40.0	30.0	12.5	0.0	100.0
Hawks and owls	40	12.5	22.5	47.5	17.5	0.0	100.0
Furbearers	40	5.0	30.0	45.0	20.0	0.0	100.0
Endangered or threatened	40	10.0	22.5	30.0	35.0	2.5	100.0
Waterfowl	40	5.0	17.5	45.0	17.5	15.0	100.0
Nongame mammals	40	2.5	27.5	55.0	15.0	0.0	100.0
Shorebirds	40	2.5	2.5	12.5	20.0	62.5	100.0

*Usable responses.

§Percentage of repsondents reporting each degree of interest.

little interest in understanding the life histories and ecology of wildlife species or in developing and using observational skills.

Two out of five respondents reported that when attempting to develop forest management plans the economic considerations of forest owners created problems, and 14 per cent cited educational problems and/or unrealistic wildlife management goals as major difficulty in integrating wildlife and forestry management. On the other hand, about 14 per cent reported that their work with landowners was impeded by the owners' concern over wildlife impacts on timber and tree regeneration. Most of the State foresters (74 per cent) reported that forest owners considered the major type of barrier to wildlife management to be based on economics. Problems involving the failure of informational and educational materials to reach the landowner and time constraints were given as barriers by 11 and 14 per cent of the respondents, respectively.

The respondents believed that most (72 per cent) of the forest owners perceived State foresters as qualified to make wildlife management recommendations. The owners' perceptions of foresters' qualifications are important for management of both timber and wildlife resources on private forestlands, and any improvement in this perception of credibility will further enhance the foresters' ability to influence the owners to manage their lands for the benefit of wildlife.

CONCLUSIONS AND IMPLICATIONS

This study demonstrates clearly that State foresters in New York have a moderate to high degree of interest in the wildlife resources they affect through forestland planning and management. These foresters vary widely in both academic and in-service educational background with respect to wildlife, but most believe that in comparison with their peers they are average or above average in their wildlife expertise. Whether this level of expertise is adequate cannot be judged here; nevertheless, they are regularly being sought by private forest owners to make wildlife management recommendations. Most foresters routinely handle these requests without the assistance of wildlife specialists. Foresters may be able to improve their effectiveness in forest wildlife management if their communication with wildlife biologists were improved.

The State foresters who participated in this study indicated that information on current wildlife management techniques for private forests and on the status of various wildlife species are of more interest to them than formal in-service training. Development of mechanisms to ensure that foresters regularly receive such information would be desirable. This represents a significant opportunity for wildlife biologists to assist and influence foresters regarding wildlife management recommendations for private forestlands.

From an educational standpoint, despite prior perceptions to the contrary, State foresters seem to be a willing and receptive audience for appropriately designed and delivered wildlife information and educational materials. Furthermore, they represent a tremendous resource as a wildlife education delivery system and as a source of assistance for on-site management. The survey respondents reported that their clients were interested in wildlife as part of the forest management process, but that knowledge barriers often exist that impede good management. If wildlife biologists could help these foresters develop the wildlife knowledge and expertise they need and desire, significant improvement might be realized in the forest wildlife resources of New York. The motivation for wildlife biologists to continue and to increase their cooperation with State foresters is supported, not only by the foresters' receptivity to such efforts as shown by the present study, but also by their prediction of continued or even increasing interest among private forest owners in the wildlife resources on their lands. Such cooperation may serve to increase the acreage of private forests brought under sound management in New York—land that should produce needed "crops" of both forest products and wildlife.

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AGE AND GROWTH OF TROUT-PERCH IN LAKE CHAMPLAIN[1]

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ABSTRACT

Trout-perch were collected by bottom trawl from two ecologically distinct areas of Lake Champlain. Scales and otoliths were taken from a total of 459 fish. Most of the specimens (89 per cent) were from 1 to 3 years old. Females averaged 2.5 years and males 1.5 years. Females were much more abundant, especially in older age groups. All age 5 and 6 and most age 4 fish were females. Ages as determined from otoliths agreed with those based on scales for only 50 per cent of the fish. Growth rates were comparable to those reported in some other studies. Differences in growth rates and in age and sex composition between the two parts of the study area are discussed.

The trout-perch (*Percopsis omiscomaycus*) is an abundant forage species in large lakes and their tributaries in central and northern North America. Magnuson and Smith (1963) reported it to be important to yellow perch and walleye populations, while Lawler (1954) found it to be an important item in the diet of northern pike. In Lake Champlain, the trout-perch has been taken in large numbers in otter trawls at depths of from 6 to over 60 meters. Anderson (1973) reported that more than half the forage fish from depths of 18 to 24 meters in the Northeast Arm of the lake were trout-perch and that they were very abundant from 6 to 12 meters deep in Malletts Bay. Their abundance in Lake Champlain indicates a significant potential contribution to the forage. Gately (1974) reported trout-perch to be the third most utilized forage species, preceded by yellow perch and rainbow smelt. Plosila (1977) found it to be the third most frequently occurring forage species in bottom trawls, after the rainbow smelt and slimy sculpin. Although it is abundant in Lake Champlain, its potential as forage may not have been reached. Anderson (1972) speculated that trout-perch may become more important as forage if rainbow smelt stocks are reduced significantly by the increasing numbers of salmonids being stocked in the lake.

This study compares the age composition and growth characteristics of trout-perch in two environmentally distinct and geographically isolated areas of Lake Champlain. Also, the relatively large otoliths of the species

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are compared with scales for use in age determination. Scales have been used successfully for aging trout-perch (Magnuson and Smith, 1963; Bostock, 1967; Watkins, 1974; House and Wells, 1973) but no information has been published on the use of otoliths for this purpose.

STUDY AREA

Lake Champlain is the largest deep-water oligotrophic lake in the United States, except for the Great Lakes. It has an area of 1,124 square kilometers and is 122 meters deep. The lake is divided geographically into five distinct basins (Potash et al., 1969). Sampling for the present study was done in the Main Lake and the Northeast Arm (Figure 1). The deep-water portions of both these basins are considered oligotrophic, while certain bays of each are more mesotrophic (Myer and Gruendling, 1979).

METHODS

Trout-perch were collected with an 8-meter bottom trawl, with 5-centimeter stretch mesh body and 1-centimeter stretch mesh cod end liner, towed for 10 minutes. Fish for the Main Lake sample were taken in one net haul on June 25, 1979 at a depth of 19 to 34 meters. Three hauls were made on July 20, 1979 in the Northeast Arm at depths varying from 18 to 29 meters.

The first collected were frozen on board the research vessel soon after capture and then thawed at room temperature in the laboratory prior to measurement. Weight was recorded to the nearest tenth of a gram, and total length to the nearest millimeter. Sex was determined by visual examination of the gonads. Age was determined from scales and otoliths for all fish. Scales were removed from the left side above the lateral line in the area just below the dorsal fin. A few scales were removed from the area of the caudal peduncle when scales were missing from the area below the dorsal fin. Scales were mounted directly between glass slides and magnified to approximately 43X with a microprojector. The length-weight relationship was calculated for each area.

The left sacculus otolith was removed from each fish and viewed with a zoom stereoscopic microscope. The otoliths were hand ground on 600-grit carbimet paper (Facey and LaBar, 1981), placed in water against a dark background and illuminated from above to facilitate interpretation of annular rings. The opaque zone was interpreted as material deposited during the slow growth of the winter. Assuming that hatching occurred during the summer, the center hyaline zone represented the period of yolk absorption. Therefore, the second opaque zone was interpreted as representing the end of the first year's growth, and so forth for each age group.

A computer program (Hesse, 1977) was used to calculate mean length and mean weight and the body-scale and length-weight relationships.

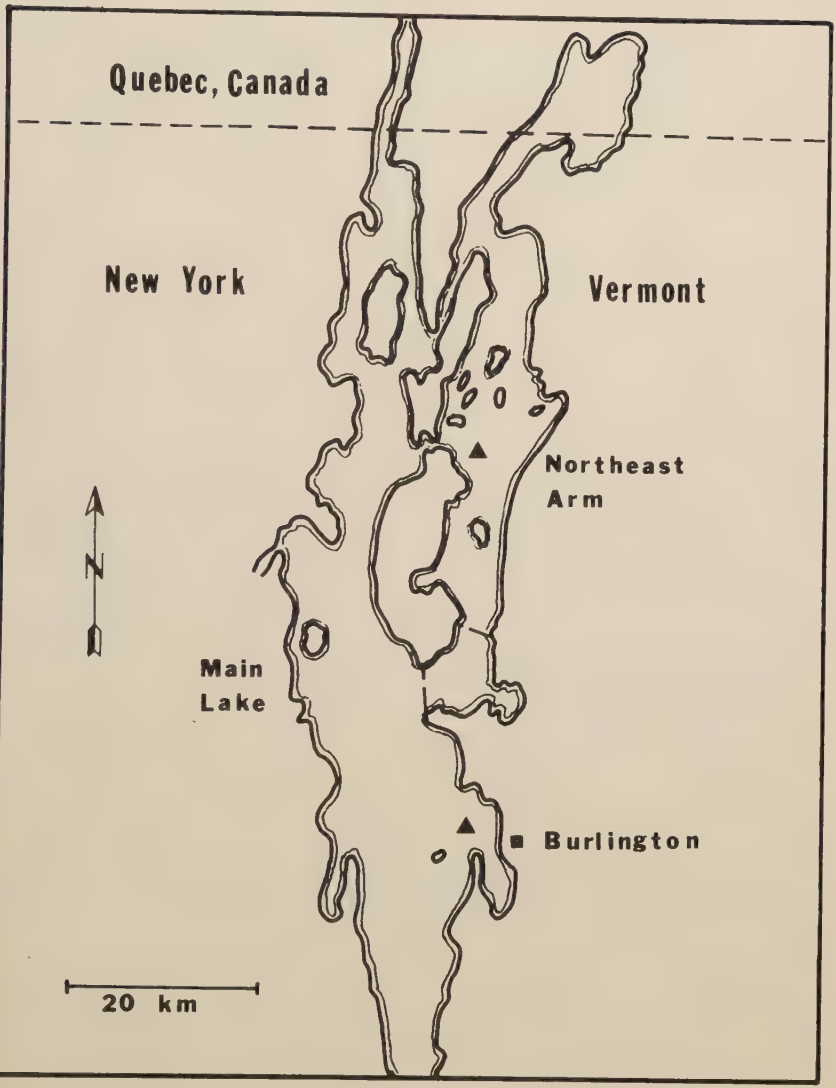

Figure 1. Map of northern Lake Champlain showing the Main Lake, Northeast Arm and Mallets Bay. Triangles indicate collection sites.

RESULTS

The data were analyzed with respect to the composition of the population and the growth characteristics of the species.

AGE COMPOSITION AND SEX RATIO

A total of 459 fish were aged, but 12 could not be aged with scales. Most were from 1 to 3 years old. These age groups comprised 83 per cent and 91

Table 1. Age Composition and Sex Ratio of Trout-perch From Two Areas of Lake Champlain

Age group	Main Lake		Northeast Arm	
	Number	Female (per cent)	Number	Female (per cent)
0	1	0	5	20
1	43	70	56	63
2	79	91	48	85
3	59	92	118	98
4	26	100	12	92
5	8	100	1	100
6	0	. .	1	100
Total	218	90	241	86

per cent of the total samples from the Main Lake and Northeast Arm, respectively (Table 1). Ages in the Main Lake ranged from 0 to 5 years for females and from 1 to 3 years for males. In the Northeast Arm, ages ranged from 0 to 6 years for females and from 0 to 4 years for males. Age 2 fish were most common in the Main Lake and age 3 fish in the Northeast Arm.

The average age of females and males was 2.5 and 1.5 years, respectively in both sampling areas. Females were much more abundant than males in all age groups for which samples were adequate, and they generally became more abundant in older age groups (Table 1). All age 4 and 5 fish from the Main Lake, and all age 5 and 6 fish from the Northeast Arm, were females. There were more immature fish and more small age 1 fish in the Northeast Arm than in the Main Lake (Figure 2). All age 1 fish were mature except six from the Northeast Arm.

Only about half (219 of 433) the ages judged from otoliths agreed with the ages based on sales and, of those which did not agree, nearly all (94 per cent) were older than those based on scales. There was much more agreement for fish from the Northeast Arm (69 per cent) than for those from the Main Lake (31 per cent). Among fish from both areas, there was agreement on age for 51 per cent of the females and 57 per cent of the males.

Length-frequency Distribution

Total length for both males and females ranged widely with extensive overlap between age groups in both areas (Figure 2). Females had a wider size range than males within all age groups adequately represented, but this may have been caused by their greater over-all abundance.

Because of the wide overlap, length-frequency analysis was not an accurate means of aging. One length interval (95-99 millimters) was represented in three age groups from populations in both the Main Lake and the Northeast Arm. Although the range of lengths was greater for younger groups (age 1 and 2), more overlap occurred between older age groups.

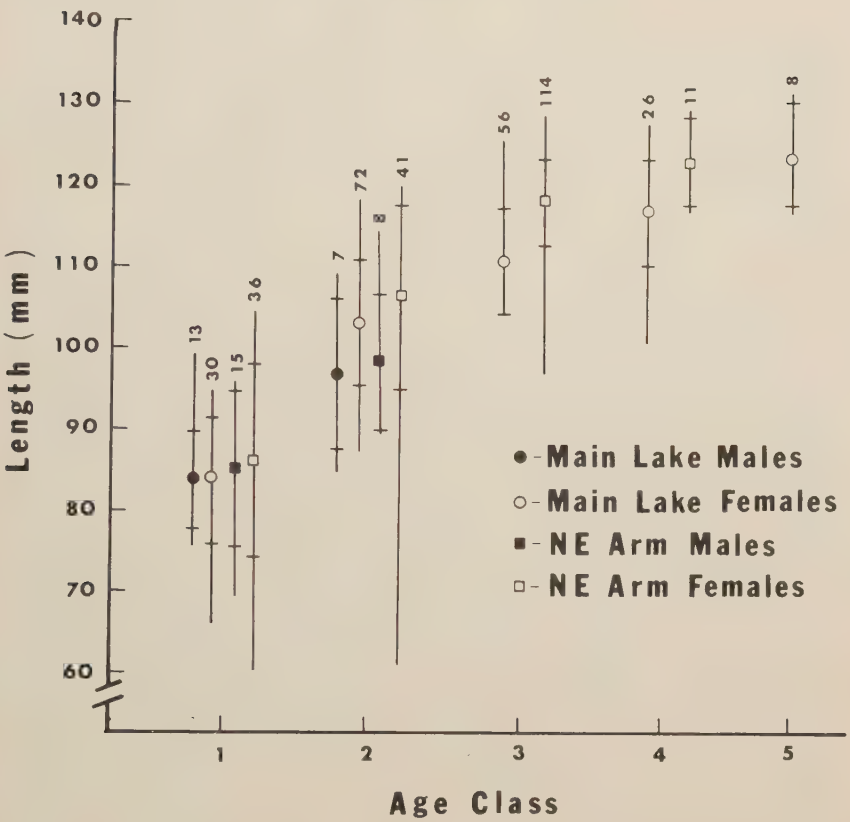

Figure 2. Total length in relation to age and sex for trout-perch in Lake Champlain. In each case, vertical line represents length range and symbol the mean. Horizontal bars through vertical line represent limits of standard deviation. Number over vertical line is sample size.

It may also be noted that, for all fish 2 years old and older, backcalculation of length at the time of first annulus formation showed that males from the Northeast Arm (mean = 69.6 millimeters) were significantly ($P < 0.10$) longer than males from the Main Lake (mean = 63.0 millimeters). Also, males from either area were significantly ($P < 0.01$) longer than females from both the Northeast Arm (mean = 58.4 millimeters) and the Main Lake (mean = 59.4 millimeters). However, females from the two areas were not significantly different.

LENGTH-WEIGHT RELATIONSHIP

The length-weight relationship for 218 trout-perch from the Main Lake was described by the following equation for which $r = 0.96$.

$$\text{Log}_{10} W = -4.8267 + 2.8809 \text{Log}_{10} L$$

The equation for 241 fish from the Northeast Arm, for which $r = 0.98$, was

$$\text{Log}_{10} W = -5.0745 + 3.0079\text{Log}_{10} L$$

The slopes of both regressions were significantly different ($P < 0.001$). As indicated by the equations, fish in the Northeast Arm grew slightly faster in weight relative to length than did those in the Main Lake.

DISCUSSION

The preponderance of females in trout-perch populations has been noted by other authors. Kinney (1950) offered two hypotheses to explain the seemingly high number of females in Lake Erie: differential mortality and/or sexual segregation, with males living in a habitat type not sampled. While both factors may be operating in Lake Champlain, the first hypothesis seems more likely. Trawl hauls during the present study were made at depths ranging from 12 to 34 meters, and there were no reported occurrences of trout-perch either in the shallow areas of the lake or in tributary streams. However, trout-perch have been collected in New York streams tributary to Lake Champlain (Lawrence Strait, N.Y.S. Department of Environmental Conservation, personal communication, 1982). In Lake Erie, where growth is rapid, Kinney (1950) reported that nearly all adult males and the larger females of age group 1 died after spawning once, while the smaller adult females lived to spawn in subsequent years. In Lower Red Lake in Minnesota, males spawned three times and some females may have spawned four times (Magnuson and Smith, 1963). It is also possible that males were displaced to the spawning areas prior to the females. Trout-perch spawned in shallow water along beaches and in streams in Lower Red Lake. Scott and Crossman (1973) believe that most eastern Canadian populations are stream spawners. In Lake Champlain, many individuals of both sexes were ripe when collected (June in the Main Lake and July in the Northeast Arm). However, it is not known where spawning takes place.

The higher frequency of smaller and younger fish in the Northeast Arm may be explained by the fact that these age groups were sampled a month later and thus were more susceptible to sampling. In June in the Main Lake, the smaller fish may have passed more easily through the 1-centimeter mesh cod end of the net. The additional month of growth in fast-growing immature individuals may have enabled more fish of the first age group in the Northeast Arm to become large enough to be retained in the otter trawl. This would also explain the wider size range of age 1 fish (50-109 millimeters) in the Northeast Arm as compared with those in the Main Lake (65-99 millimeters). In age 2 fish, the size range was less divergent (Main Lake—80-124 millimeters; Northeast Arm—85-124 millimeters). At this age, similar proportions of the total population in each area are probably equally susceptible to sampling.

These are obvious aging discrepancies between otoliths and scales.

Unfortunately, the authors have no basis for claiming more accuracy for either method. Magnuson and Smith (1963) believed that the scale method was reliable because scales from age 0 fish lacked an annulus at the end of August and the smallest trout-perch collected in early June either did not have an annulus or had one just forming on the edge of the scale. Both Magnuson and Smith(1963) and Watkins (1974) were able to relate ages based on scales to length-frequency distributions. Although the present authors could not consistently determine age from length, it appears that the use of otoliths may result in overestimating the true age of trout-perch in Lake Champlain.

Growth rates reported by Kinney (1950) for trout-perch in Lake Erie were similar to those calculated for Lake Champlain. In Lake Erie, age 1 and older trout-perch ranged from 65 to 92 millimeters in total length, and maximum total lengths of 120 and 106 millimeters were attained by age 2 and older females and males, respectively (converted from standard lengths). Kinney stated that this difference between the sexes after the second year of life was due to the effects of spawning mortality in those males large enough to mature by their second summer. Similar observations were made by Magnuson and Smith (1963). The same effect may occur among trout-perch in Lake Champlain since males from both areas were sexually mature by their second summer (2 + fish). Also, since so few age 2 or older males were collected, combining both sexes probably did not significantly alter the determination of growth increments for 2 + and older groups.

Separate populations of trout-perch exhibited different growth rates (Figure 3). Trout-perch from the Northeast Arm of Lake Champlain exhibited the next fastest growth rates, and fish from the Main Lake of Lake Champlain, Lower Red Lake and southeastern Lake Michigan all showed similar growth. Fish from the Main Lake grew faster at first but were overtaken during the third season by fish in Lower Red Lake and in the fourth season by fish in southeastern Lake Michigan. Trout-perch from Lake Superior grew the slowest of all.

Bostock (1967) suggested three possible factors that may cause differences in growth rates, i.e., enviromental differences, genetic differences, and differences in population size. It is difficult to pinpoint the specific cause of the difference noted in Lake Champlain without extensive study of both areas. Trout-perch are known to feed primarily on benthic invertebrates (Kinney, 1950; Bostock, 1967). Since benthic communities vary considerably between the major basins of Lake Champlain (Myer and Gruendling, 1979), available food resources may offer a sufficient explanation for differences in growth. The two areas are ecologically different with the sampled area of the Main Lake being more eutrophic than the Northeast Arm. It is possible that the two groups represent separate populations since there is a nearly complete separation between the two areas. However, little is known of the movements and spawning areas of the

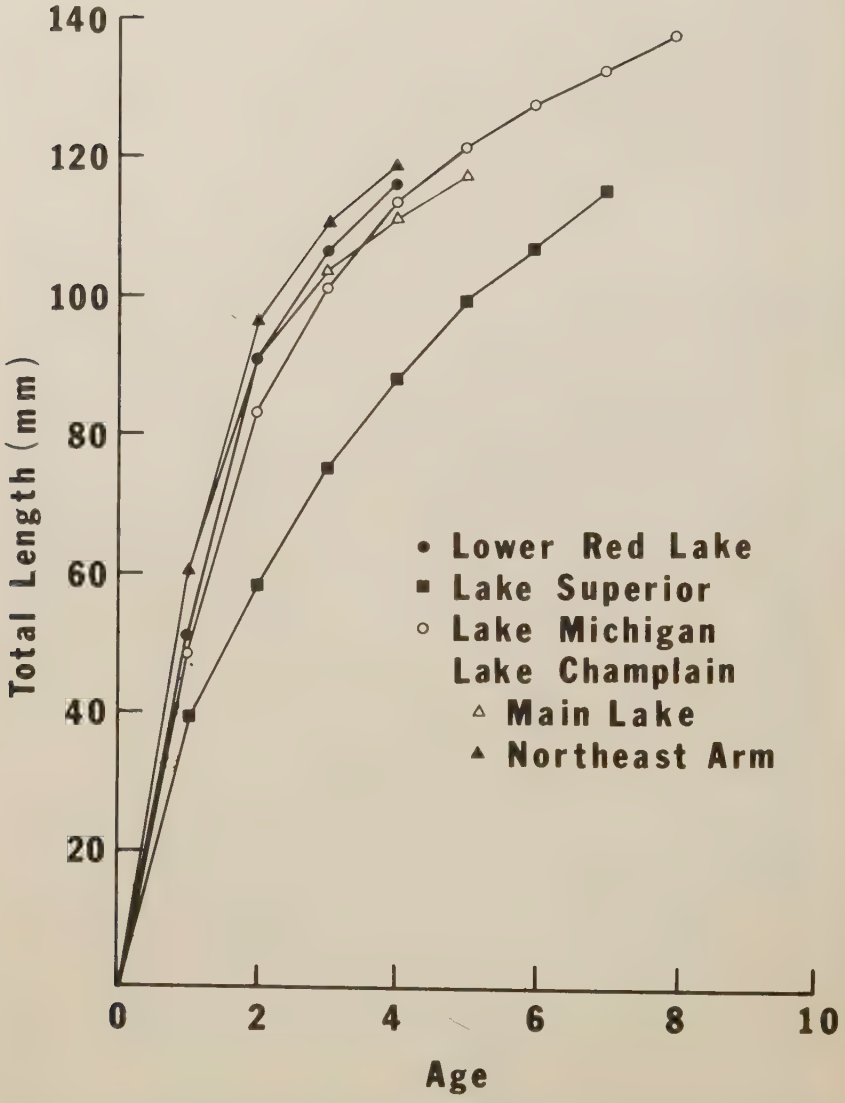

Figure 3. Growth rates of trout-perch from Lower Red Lake (Magnuson and Smith, 1963), Lake Superior (Bostock, 1967), Lake Michigan (House and Wells, 1973) and Lake Champlain.

trout-perch of Lake Champlain, and therefore genetic isolation between the two populations cannot be assumed.

There may also be differences in population size between the areas due in part to differences in the predator populations. Most salmonids stocked under the program begun in 1972 by the Vermont Fish and Game Department and the New York State Department of Environmental Con-

servation have been released in the Main Lake and Malletts Bay. Fewer salmonids were stocked in the Northeast Arm prior to 1980 (J. Anderson, Vermont Fish and Game Department, personal cimmunication). If these predators selected the larger trout-perch, this could help to explain the decrease in growth after the first year for fish in the Main Lake compared with those in the Northeast Arm. However, salmonid predation may also lead to increased growth rates because of a decrease in intraspecific competetion. A more detailed study of salmonid/forage fish interactions would be required to reach definitive conclusions.

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ATTITUDES OF MARINE BOAT ANGLERS IN NEW YORK TOWARD POTENTIAL SPORT-FISHING REGULATIONS[1]

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ABSTRACT

Interview data from 638 marine boat anglers fishing in New York waters in 1980 were analyzed with respect to their attitudes toward four sport-fishing regulations that might be imposed for fishery management, i.e., catch limits, size limits, limits on the number of rods and lines per angler, and prohibition of the sale of sport-caught fish. At least half of these anglers either favored or were neutral toward these regulations, assuming some regulation was needed. Also, 70 per cent or more indicated that, if any of the regulations were imposed, they would continue to fish as frequently as they had in 1980. However, significantly more charter/party boat anglers than private/rental boat anglers were opposed to regulations and said they would fish less if they were imposed. Catch data indicated that the vast majority of the fish taken were caught by a minority of anglers whose daily catches included 10 or more fish of the species they primarily sought. It was concluded that a minimum size limit would meet with the least opposition from anglers and at the same time potentially reduce the total catch.

Recent estimates by the National Marine Fisheries Service (1980a) indicate that 1.3 million recreational fishermen made 7.5 million fishing trips from New York ports into marine waters in 1979. These anglers reportedly brought ashore 29.6 million pounds of finfish not including sharks or skates, while commercial fishermen in New York landed 25.1 million pounds of finfish in the same year. Competition between recreational and commercial fishermen for the same marine fishery resources has long been recognized in New York (Jensen, 1977; McHugh and Ginter, 1978). The recreational and commercial catches are compared for several species-groups in Table 1 to illustrate their importance to both these fisheries. Since a common resource is used, it is ineffective to attempt to manage only the commercial catch without also managing the recreational catch (McHugh, 1980; Ginter, 1974).

Various authors (McHugh, 1972; Ginter, 1974; Jensen, 1977) have noted that New York's efforts to manage marine finfish in its territorial sea have been inadequate and that there are no catch limits on these fish. However, the Environmental Conservation Law provides minimum size limits for 12 species with respect to the commercial fishery and five species with respect to the recreational fishery. As increasing recreational and

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TABLE 1. COMPARATIVE HARVESTS OF SELECTED FINFISH BY RECREATIONAL AND COMMERCIAL FISHERMEN IN NEW YORK IN 1979

Species*	Harvest (weight in pounds)	
	Recreational§	Commercial†
Bluefish (*Pomatomus saltatrix*)	12,039,478	1,611,384
Cod (*Gadus morhua*)	3,186,007	480,099
Scup-porgy (*Stenotomus chrysops*)	2,799,972	3,135,005
Tautog-cunner (*Tautoga onitis* and *Tautogolabrus adspersus*)	1,103,907	58,297
Striped bass (*Morone saxatilis*)	775,416	535,079
Weakfish (*Cynoscion regalis*)‡	676,740	1,511,600

*Although flounders (Bothidae and Pleuronectidae) constitute an important part of the catch of both recreational and commercial fishermen, harvest figures are not given because of the variety of species involved and the different composition of the catches by the two groups of fishermen.

§Data for period November 1978 to October 1979 as reported by National Marine Fisheries Service (1980a).

†Data from National Marine Fisheries Service (1980b).

‡Reported in commercial statistics as "grey sea trout".

commercial fishery demands are made on the State's marine fishery resources, managers will need to consider regulations to restrict the recreational catch and to ensure that it does not exceed its share if allocations between the recreational and commercial catches become necessary.

Four potential regulations for marine recreational angling were considered by Dawson and Wilkins (1981) to be appropriate for use where needed in the Mid-Atlantic region: (1) limit the catch kept per angler per day; (2) set minimum size limits on fish kept; (3) limit each angler to two fishing rods and lines; (4) prohibit the sale of fish caught by anglers. More than half the marine boat anglers from New York and Virginia whom they interviewed reported that they either favored or were neutral toward these four regulations, assuming some regulation was needed. A minimum size limit was the most acceptable of the four to the anglers interviewed; more than 80 per cent either favored this regulation or were neutral. However, 83 per cent reported that their rate of participation in fishing would not be affected, regardless of which regulations might be imposed.

The interviews with New York and Virginia anglers also substantiated the findings of other studies as reported by Dawson and Wilkins (1980) that anglers made fishing trips for a variety of reasons, such as having fun, changing from daily routines, social interaction, enjoying the scenery and catching fish. While catch-related motives were important to these anglers, they did not rank as most important. The present paper further assesses the data for New York anglers regarding: (1) the hypothesis that different types of anglers have different preferences for the four management regulations; and (2) the potential impact of these regulations on the fisheries and fishery industries.

The data were obtained by an intercept interview survey of marine anglers made in conjunction with the marine recreational fishing survey of

the National Marine Fisheries Serivce in 1980. Only a random sample of those anglers fishing from boats in waters off New York (and landing in New York State) during the period from May 1 to October 31 in 1980 were selected for interview. Of the 797 anglers selected, 638 (80 per cent) cooperated in the interview and 159 (20 per cent) refused. No data were available to test for possible differences between the preferences of cooperators and noncooperators. It was assumed that the relatively high rate of cooperation minimized any potential bias. In analyzing the data, anglers who fished from charter and party boats were compared with those who fished from private and rental boats.

Preferences For Regulations

The preferences of the anglers interviewed are summarized in Table 2 in which the regulations are listed in the order of acceptability. At least half the anglers either favored or were neutral toward all four, assuming some regulation was necessary. A minimum size limit was the most acceptable to the fishermen of both groups, while for the other regulations the proportions within each angler group were similar. For the three regulations other than the prohibition of the sale of sport-caught fish, a significantly greater proportion (chi-square $>$ 3.84, $P = 0.95$ with 1 d.f.) of the charter/party boat anglers were opposed.

Panek and Lamson (1980) reported that 82 per cent of the marine anglers in their study on eastern Long Island (N.Y.) favored regulations to set a minimum size limit and establish a daily catch limit. Thus, both studies indicated that a substantial proportion of anglers would favor or at least be neutral toward these marine angling regulations.

An angling regulation, when needed, should reduce the total catch without substantially decreasing over-all participation and thereby help maintain both the fishery resources and angler-based industries. If any of

Table 2. Preference of Marine Anglers Interviewed in New York in 1980 For Different Regulations, According to Type of Boat Used

	Charter and party boats			Private and rental boats		
		Preference (per cent)			Preference (per cent)	
Regulation	Number	Favor or neutral	Oppose	Number	Favor or neutral	Oppose
Minimum size limit	133	70	30	474	90	10
Limit of two rods and lines per angler	132	56	44	471	69	31
Prohibition of sale of sport-caught fish	132	55	45	474	62	38
Daily catch limit	132	50	50	475	61	39

TABLE 3. PROPORTION OF MARINE ANGLERS INTERVIEWED WHO SAID THEIR PARTICIPATION IN FISHING WOULD BE THE SAME, DECREASE OR STOP UNDER THE REGULATIONS CONSIDERED, ACCORDING TO TYPE OF BOAT USED

Regulation	Charter and party boats				Private and rental boats			
	Number	Proportion (per cent)			Number	Proportion (per cent)		
		Same	Decrease	Stop		Same	Decrease	Stop
Minimum size limit	121	79	18	3	368	93	6	1
Limit of two rods and lines per angler	121	79	18	3	376	91	7	2
Prohibition of sale of sport-caught fish	121	79	19	2	378	90	9	1
Daily catch limit	125	70	25	5	387	89	10	1

the four regulations were imposed, 70 per cent or more of both angler groups reported they would continue to fish as frequently as they had in 1980 (Table 3), but a significantly greater proportion (chi-square > 6.00, $P = 0.95$ with 2 d.f.) of the charter/party boat anglers than of the private/rental boat anglers reported that they would decrease or stop their fishing participation. The four regulations are listed in Table 3 according to the percentage of the anglers who would continue fishing as often as they had in 1980 despite the restrictions. A daily catch limit would have the greatest potential impact on participation and the other regulations would have similar but less impact on both groups of anglers.

Angler Catch

The proportion (58 per cent) of charter/party boat anglers who caught fish on the trip for which they were interviewed was significantly higher (chi-square > 3.84, $P = 0.95$ with 1 d.f.) than that (48 per cent) for private/rental boat anglers. Also, 38 and 29 per cent of the two groups, respectively, brought some catch ashore in whole form that could be identified and measured by the interviewers (catch type A as reported by the National Marine Fisheries Service, 1980a). Catch data are given here for the five species or species-groups that included the principal fish sought by marine boat anglers in these waters. Furthermore, the figures apply only to the catch of those anglers who ranked these species as their first or second choice among the ones sought on that fishing trip. The proportion of anglers who took different quantities of these species and the proportion of the catch accounted for by these quantities per angler are summarized in Table 4, together with comparative figures for the catch of all species by fishermen on the two types of boats.

Of the anglers who reported that bluefish were their first or second choice, 29 per cent returned with bluefish in whole form. The catch ranged from one to more than 50 fish per angler with a mean of 2.8 fish for all anglers who sought bluefish. Although only 3 per cent of the bluefish anglers caught more than 20 fish, these anglers took 36 per cent of the total catch. Similarly, while only 9 per cent of the bluefish anglers caught more than 10 fish, they took 63 per cent of the total catch. Thus, in this case, a catch limit of 10 ot 20 bluefish per day would affect only a minority of anglers but would potentially produce a significant reduction in the catch.[3] On the other hand, a minimum size limit of 550 to 650 millimeters would have to be imposed to produce a similar reduction in the catch (Table 5).

With respect to scup and porgy, 43 per cent of the anglers returned with fish in whole form. The catch ranged from one to more than 50 fish per angler, with a mean catch of 9.3 fish for all anglers who sought these

[3]Similar proportions of charter/party boat anglers and private/rental boat anglers brought ashore more than 10 bluefish (11 and 8 per cent, respectively). However, no other species was caught in sufficient numbers by both types of anglers to warrant comparisons.

TABLE 4. PROPORTION OF ANGLERS WHO TOOK DIFFERENT QUANTITIES OF FISH, AND PROPORTION OF THE TOTAL CATCH ACCORDING TO DIFFERENT QUANTITIES TAKEN BY THE ANGLER, FOR FIVE SPECIES GROUPS AND FOR TWO TYPES OF BOATS

Number of fish taken by angler*	Species-group					All species	
	Bluefish	Scup-porgy	Weakfish	Tautog-cunner	Flounder	Charter and party boats	Private and rental boats
	Proportion of anglers (per cent)§						
0	71	57	81	66	73	62	71
1- 5	13	7	7	9	17	20	13
6-10	7	10	5	9	5	9	5
11-15	5	6	2	6	1	5	3
16-20	1	3	3	8	2	1	3
21-30	2	9	2	2	2	1	3
31-50	0	5	0	0	0	2	1
51-or more	1	3	0	0	0	0	1
Total	100	100	100	100	100	100	100
Number of anglers	288	72	57	53	284	196	601
Mean number of fish taken per angler	2.8	9.3	1.8	3.4	1.9	3.4	3.5
	Proportion of total catch (per cent)						
1- 5	15	5	12	6	22	15	9
6-10	22	10	11	22	19	20	12
11-15	23	7	29	18	9	19	12
16-20	4	7	32	42	22	9	13
21-30	19	22	16	12	23	8	23
31-50	4	29	0	0	5	29	15
51 or more	13	20	0	0	0	0	16
Total	100	100	100	100	100	100	100
Number of fish	872	794	174	210	593	658	2,081

*Includes only fish brought ashore in whole form.

§Includes only those anglers who ranked these species as their first or second choice among the ones sought on that fishing trip.

Table 5. Percentage of Fish Caught, According to Size, For Five Species Groups and For Two Types of Boats*

Total length (millimeters)	Species group					All species	
	Bluefish	Scup-porgy	Weakfish	Tautog-cunner	Flounder	Charter and party boats	Private and rental boats
150 or less	1	11	0	0	0	1	5
151-250	2	64	0	7	16	5	26
251-350	1	15	0	48	43	5	25
351-450	12	9	23	40	31	6	24
451-550	10	1	26	4	7	6	8
551-650	19	0	28	1	1	17	5
651-750	18	0	14	0	1	22	2
751-850	30	0	7	0	0	37	1
851 or more	7	0	2	0	1	1	4
Total	100	100	100	100	100	100	100
Number of fish	459	260	57	106	320	361	919

*Inclues only a random subsample of the fish brought ashore in whole form.

species primarily (Table 4). While 17 per cent of the anglers took more than 20 fish, they took 71 per cent of the catch reported. A size limit of 250 millimeters would have to be imposed to produce a similar impact on the number of scup and porgy caught and brought ashore (Table 5).

Similar analyses of the data for weakfish, tautog-cunner and flounder suggest that catch limits of 10 to 20 fish per angler would affect a minority of the fishermen but would potentially produce a significant reduction in the catch. The figures in Table 5 indicate the size limits that would have to be imposed to product similar reductions in the catch.

There was relatively little difference between the charter/party boat and private/rental boat anglers with respect to the quantity of fish caught according to the distribution of either successful anglers or the total catch (Table 4). However, there were substantial differences between the two angler groups in the size distribution of the fish caught (for all species), although this was mainly a result of differences in the species sought by each group (Table 5). For example, large bluefish were more often caught by charter/party boat anglers, while small species such as scup and porgy were more often caught by private/rental boat anglers.

No catch data were available to assess the potential impact of regulations to limit each angler to two fishing rods and lines or to prohibit the sale of fish caught by anglers. It is assumed that neither of these regulations by itself would have as great an impact on the catch as was generally shown for daily catch limits or minimum size limits.

DISCUSSION

Results of this survey show that half or more of both the charter/party boat anglers and the private/rental boat anglers either favored or were neutral toward the four regulations considered, assuming some regulation was needed. However, charter/party boat anglers were more likely than private/rental boat anglers to oppose sport-fishery regulations and more often reported that their rate of fishing participation would decrease if any of these regulations were imposed. A daily catch limit was the one most often oposed by the anglers generally and the one that would have the greatest potential impact on angler participation. The regulation that the anglers most often favored or were neutral toward and that would reduce participation the least was a minimum size limit. Also, 70 per cent or more of both angler groups reported that their participation would not be affected, regardless of which regulation might be imposed. Therefore, either a minimum size limit or a daily catch limit could be used to reduce the total catch where needed without adversely affecting total angler participation.

A minimum size limit would probably receive angler acceptance if it was shown to be needed. Most anglers see this type of regulation as: (1) a fishery conservation measure that would potentially allow more smaller

fish to increase in size, reach maturity and help maintain the stock; and (2) acceptable since such regulations have already been used to some extent for marine fisheries in New York. Actual use of minimum size limits as a management regulation would require assessments of the population status of the species involved. Actual length-frequency distribution curves could be developed for each species to determine the impact of various minimum size limits on the total catch and the resulting effect on the population.

The hypothetical nature of the inferences drawn from the data reported here should be recognized because they represent the reactions anglers presume they would have, rather than their actual reactions, to the regulations considered. Their actual reactions would depend on factors such as: how limiting the regulation was, the type of fishery affected, the angler's interest in fishing, alternate fishing experiences available, etc. In any case, only a few of the anglers reported that they would stop fishing completely if any regulation were imposed.

That a daily catch limit would be the least acceptable of the four regulations presented to the anglers probably reflected their concern over lost opportunities on those days when fishing was exceptionally good since about half the anglers did not catch any fish on the trip for which they were interviewed. The data also showed, for example, that a daily catch limit of 10 to 20 bluefish would affect only a minority of the bluefish anglers but potentially would result in a large reduction of the total catch. The effects of such regulations might be offset somewhat by: (1) anglers sharing the catch within a boat on a given day to circumvent the regulation, and (2) anglers fishing more frequently during the season. More in-depth analysis of the statistics recorded for New York in connection with the marine recreational fishing surveys of the National Marine Fisheries Service might be used to develop catch-frequency-distribution curves for each species that would indicate the impact of various catch limits on the total catch and the population.

Although limited, the information presented here suggests that minimum size limits (to protect small fish) or daily catch limits (to reduce or limit the total catch), if needed, would be acceptable to the majority of private/rental boat anglers as well as about half the charter/party boat anglers. Their impact on angler participation would be relatively low, while their effect on the total catch could be significant depending on the degree of restriction imposed, level of enforcement and other factors.

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GENERAL NOTES

GROWTH OF THE WILD TURKEY POPULATION IN WASHINGTON COUNTY, NEW YORK[1]

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The eastern wild turkey (*Meleagris gallopavo silvestris*) was historically present in New York south of a line extending eastward from the vicinity of the Niagara River through the north-central region and on to southern Vermont (Mosby, 1949). This range did not include Washington County. Turkeys became extinct in New York sometime after 1844 (Eaton, 1910).

In the late 1940's turkeys moved into southern Allegany and Cattaragus Counties in southwestern New York from adjoining range in Pennsylvania (Eaton, 1953, 1964). A substantial population developed in that area and has been used to furnish birds for trap and transfer programs to reestablish the species in other parts of the State. In a related project, Vermont, by cooperative agreement, obtained 31 wild turkeys from Allegany and Steuben Counties during the winters of 1968-69 and 1969-70 and released them in two locations. One was northeast of Lake Bomoseen, and the other was southwest of West Pawlet only 2 miles from the New York-Vermont boundary (Jeffrey A. Wallin, personal communication). In 1971 turkeys were sighted in Washington County (N.Y.). This paper documents their spread in the county between 1971 and 1976.

Large tracts of forest have, historically, been considered an essential element of good turkey range. This concept was based on the distribution in colonial times of well established wild turkey populations in the forested Appalachian and Blue Ridge Mountains from New York to South Carolina (Bailey and Rinell, 1967). This view was strengthened by the fact that only small populations had successfully adapted to woodlot-agrarian locations, and these were usually adjacent to large forests. Consequently, trap and transfer programs to establish turkey populations in New York were focused on areas where large forest tracts predominated, exclusive of the Adirondacks and parts of the Catskills where winter snowfall was considered a limiting factor. Also excluded were many areas where smaller forest tracts and woodlots were distributed among agrarian lands. Washington County is part of the territory where the range was originally rated as having only secondary or teriary potential for wild turkeys. Therefore, their spread into the county from Vermont is of interest.

Eastern Washington County lies in the Taconic Foothills and Taconic Highlands ecological zones as described by Will et al. (1982). The topography is basically hills ranging in elevation from 400 to 1,800 feet. Forests occur chiefly along stream courses and on the more rugged ridges and slopes unsuited for clearing and cultivation. The principal trees are oaks, maples, beech, birch, hornbeam and ash, together with some pine and hemlock. Interspersed with the woodlands, agrarian lands (chiefly dairying) occupy less than half of the area. The western part of the county is in the Hudson Valley zone and is very largely an agricultural area.

Several methods were used to obtain reports and observations of wild turkeys in Washington County. During the spring of 1971 a questionnaire was mailed to town highway superintendents and to conservation officers working in the county. In the spring of 1972, an extensive survey of over 150 landowners was made throughout the towns bordering Vermont. From 1971 through 1976, reports were obtained by questioning landowners, people attending sportsmen club meetings, people visiting the State Department of Environmental Conservation's display at the Washington County Fair, hunters at deer checking stations, and county and town highway and public works employees. Wildlife personnel and conservation officers reported information obtained from other people while working in the county, and wildlife personnel searched for wild turkeys or sign (tracks) during the winter.

Occasionally, interested people would telephone the Department's regional office to report seeing wild turkeys. Most reports were considered unverified, especially those from locations where turkeys had not previously been observed, unless they came from persons known by

[1]The authors acknowledge the assistance of Fish and Wildlife Technicians Jack Harnish, Gary Hill, David Kenyon and Richard Spinks, as well as temporary personnel and conservation officers, in collecting observations of turkeys. Mark Brown, Gary Will and Robert Inslerman reviewed the manuscript.

Figure 1. Range expansion of the wild turkey population in Washington County and vicinity as indicated by sightings from 1971 to 1976. Sightings plotted for 1976 include only those for Saratoga and Warren Counties, plus a few in Washington County close to the county line.

Department personnel. Whenever possible, unverified sightings were checked by interviewing the observer and neighboring landowners where the turkeys had been reported in an effort to substantiate the record.

During the first two years, emphasis was placed on documenting turkeys occupying towns along the Vermont border. Later, the emphasis of the searches was along the periphery of the expanding range of the population. All records of wild turkeys deemed valid were transferred to a map of Washington County and adjoining lands having a scale of 1 inch to 1.33 miles. Several observations of turkey flocks less than half a mile apart were considered to represent the same flock. The total observations for each calendar year were considered a minimum population estimate.

Of the methods used to gather information, only three were effective. The most valuable was interviewing landowners. The second was enlisting the field staff to report turkey sightings made while performing other duties in Washington County, and the third was the regular searches for turkeys conducted by project personnel. However, observations were not recorded according to one method versus another, so it was not possible to compare them numerically.

The increase in range of wild turkeys in Washington County and vicinity from 1971 through 1976 is depicted in Figure 1. The estimated area occupied and a minimum estimated population each year, i.e., total of all birds reported, are given in Table 1. Range expansion was greatest (60.3 per cent) between 1971 and 1972 and averaged 174 square miles per year for the whole period (1971-1976). The population grew similarly, and by 1975 wild turkeys were being encountered in Saratoga and Warren Counties that adjoin Washington County on the west.

Table 1. Expansion of Range and Increase in Numbers For Wild Turkey Population in Washington County and Vicinity, 1971-1976

Year	Range			Estimated population
	Occupied (square miles)	Increase from previous year		
		Square miles	Per cent	
1971	189	. .	. .	137
1972	303	114	60.3	211
1973	435	132	43.6	467
1974	558	123	28.3	820
1975	784	226	40.5	630*
1976	1,054	270	34.4	§

*Lower number than for year before attributed to fewer personnel working in Washington County.

§Not applicable.

Table 2. Range Expansion of the Wild Turkey Population in Washington County and Vicinity Compared With That Reported For Three Other Northern States

Number of years following release	Range occupied (square miles)				
	Washington County and vicinity	Minnesota*		New Hampshire§	New Jersey†
		North area	South area		
1	189	54	83	338	50
2	303	132	181	800	190
3	435	228	223	937	200
4	558	269	477	1,000	. .
5	784	502	730	1,000	. .
6	1,054	818	860	. .	. .

*J. Ludwig, Minnesota Dept. Nat. Resources (personal communication).

§T. W. Walski, New Hampshire Fish and Game Dept. (personal communication).

†R. Erickson, New Nersey Div. Fish, Game and Shellfisheries (personal communication).

Information on the expansion of wild turkey populations in other states may be compared with these observations in New York in only a very general way because of differences in range characteristics and the manner of gathering data. Nevertheless, the figures in Table 2 for three other northern states afford a rough comparison with what has happened elsewhere.

Range expansion was rapid in Washington County where blocks of forest lands are interspersed with cleared lands. The forests serve the turkeys as breeding, nesting, feeding and roosting habitat throughout the year, while the cultivated and abandoned fields serve as feeding and brood-rearing habitat. The most rapid growth occurred in the Towns of Granville and Salem where 30.5 and 43.1 per cent, respectively, of the area was woodland (new York State Land Use and Natural Resource Inventory). Because one of Vermont's stocking sites was just across the State line in the Town of West Pawlet, it was anticipated that turkeys would move into the Town of Granville, and it was felt that the proportion of woodlands there was sufficient to provide favorable habitat. Rapid range expansion into the Town of Salem was not expected and may have occurred because of the higher proportion of forested land. However, the Department was engaged in a deer-trapping program in the southeastern towns of Washington County, and this afforded relatively more opportunity to observe turkeys and gather information from landowners throughout the Town of Salem than was the case in the Town of Granville.

The rate of expansion in range by a growing wild turkey population will vary between localities. The distribution of sightings is not wholly representative because turkeys may not occupy all the intervening range. However, the spread of turkeys in Washington County where forests are not dominant and a substantial proportion of the land is in agriculture far exceeded expectations.

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CAUSES OF MORBIDITY AND MORTALITY IN COYOTES IN NEW YORK

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Causes of morbidity and mortality in coyotes (*Canis latrans* var.) in the northeastern United States have been poorly documented. Such information is needed for understanding population dynamics and making management decisions. This note summarizes 244 necropsies by the Wildlife Pathology Unit over a 12-year period (1970-1982).

The coyotes examined were generally submitted by the public, many because of overt signs of sickness and others for species identification. Standard necropsy techniques were followed. Sarcoptic mange mites (*Sarcoptes scabiei*) were microscopically identified in skin scrapings cleared with lactophenol. The heart and associated large vessels were dissected and examined for the presence of heartworms (*Dirofilaria immitis*). If the case history and/or gross pathological findings suggested canine distemper, scrapings of epithelium from the urinary bladder were stained with Shorr's stain and microscopically examined for inclusion bodies. Of the coyotes examined, 80 per cent had died between September 21 and March 21, and at least 82 per cent had been shot, trapped or struck by motor vehicles. The major morbidity and mortality factors observed are summarized in Table 1 according to the immediate cause of death.

TABLE 1. FREQUENCY OF MAJOR MORBIDITY AND MORTALITY FACTORS OBSERVED IN 244 COYOTES FROM NEW YORK NECROPSIED DURING THE PERIOD 1970-1982, ACCORDING TO THE IMMEDIATE CAUSE OF DEATH

	Immediate cause of death				
Factor	Shooting	Trapping	Highway accident	Sarcoptic mange	Other or not recorded
Sarcoptic mange	38	8	9	6	20
Heartworm	4	1	0	0	2
Sarcoptic mange and heartworm	2	0	0	1	0
Canine distemper*	3	0	0	0	1§
Other	5	1	0	0	16
None	78	25	24	0	0

*Only coyotes with unusual behavior and/or suggestive gross pathology were tested for distemper.

§Death due to canine distemper.

Sarcoptic mange was present on 34 per cent of the specimens. Although it was considered the immediate cause of death of only seven coyotes, it probably predisposed many others to shooting or clubbing. Weakness, alopecia and abnormal behavior such as entering barns and garages or appearing oblivious to human activity often led people to destroy many that might have shortly succumbed to mange alone. The distribution of the origins of the specimens (Figure 1) indicates that mange can be expected in coyotes anywhere in the State.

Sarcoptic mange in the coyotes examined was usually characterized by alopecia, flaking skin and encrustations. These signs were generally most severe on the lower legs, perianal region and tail. The face and ears were also heavily parasitized in many cases. In contrast, the neck and dorsal aspect of the trunk were often relatively little involved. Marked enlargement of the axillary and inguinal lymph nodes was usually present. In some specimens, alopecia was associated with hyperpigmentation, little skin flaking and no encrustations. Few mange mites were observed in scrapings from these coyotes, and it appeared that recovery from a more severe stage of infestation had occurred. In three cases, extensive areas of hyperpigmentated skin and alopecia were present, but there was renewed hair growth in the alopecic areas. No mites were found in skin scrapings, and no other gross pathology related to sarcoptic mange was found except for enlarged axillary and inguinal lymph nodes. These animals

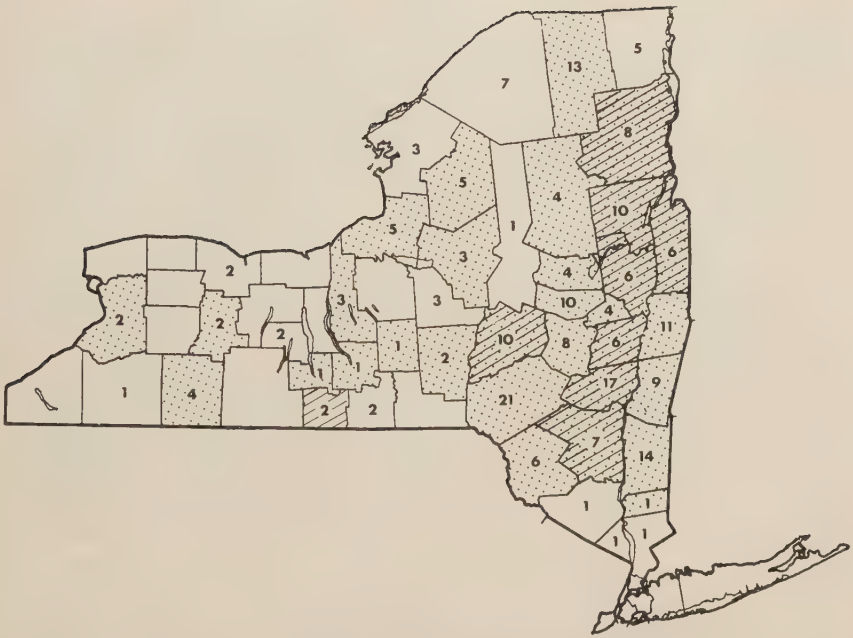

Figure 1. Distribution of counties from which coyotes infested with sarcoptic mange (stippled) and/or heartworm (barred) were submitted during the period 1970-1982. Numerals indicate number of specimens from each county that were examined for heartworms.

that were considered to be recovering were generally in excellent flesh, as were some with extensive active infestations. It appears that coyotes may occasionally survive mange infestations in the wild.

Young and Jackson (1951) reported *S. scabiei* to be common in coyotes in Colorado, Idaho, Montana and Wyoming, and to be fatal to pups. During the fall and winter of 1967-68, an outbreak in coyotes and red foxes (*Vulpes fulva*) in Wisconsin was reported by Trainer and Hale (1969). Gier et al. (1978) found it to be common in coyotes from the central prairie states (Texas to Minnesota) from 1972 to 1978. Pence et al. (1981) diagnosed infestations in coyotes, red wolves (*Canis rufus*), and red wolf X coyote and red wolf X dog hybrids from the coastal prairies of Texas and Louisiana. In New York, sarcoptic mange has been widespread and common in red foxes since at least 1970 (Stone et al. 1974; Salkin et al., 1980; Tullar and Berchielli, 1981). Since mange mites from red foxes can infest coyotes (Stone et al., 1972; Samuel, 1981), it is possible that sarcoptic mange in red foxes may contribute to its prevalence in coyotes through interspecific agression and scavenging.

Monson et al. (1973) reported on the incidence of heartworms in the specimens that were examined before mid-1972 and may have included several that were too young to have had adult worms in the heart because of the lengthy development of the immature worms in peripheral tissue (Levine, 1968). After that, nine juveniles that died prior to September 1 were excluded so that a total of 235 coyotes were examined for heartworms. Of these, 11 (4.7 per cent) had infestations. The number of works ranged from one to 33. The counties from which the infested coyotes came are shown in Figure 1, together with the total specimens from each county that were examined.

A higher ($P < 0.05$) incidence (9.2 per cent) was recorded in 98 coyotes from counties bordering the Hudson River in eastern New York than that (1.5 per cent) in 137 from the rest of the State. The Hudson Valley was identified in a survey of veterinarians in New York (Georgi and Cupp, 1975) as a major endemic area for heartworms in domestic dogs. Heartworms have also been recorded in 0.5 per cent of 551 red foxes (Monson et al., 1973) and 1.1 per cent of 180 gray foxes (Monson et al., 1973; Stone, 1974) in the State. These findings indicate that heartworms are not at present an important cause of morbidity or mortality in wild canids in New York.

The incidence of heartworms recorded (4.7 per cent) was similar to the 3.4 per cent reported for 259 coyotes in New England by Agostine and Jones (1982) and the 3.6 per cent reported for 220 in Iowa by Franson et al. (1976). An incidence of 0.6 per cent in 1,790 specimens was recorded in Kansas between 1947 and 1962 (Gier, 1968), although more recently Gier et al. (1978) reported 15 per cent among an unspecified number of coyotes on the Fort Riley Military Reservation, and Graham (1975) reported 8.0 per cent for 111 from the northeastern corner of the state. Graham also reported heartworms in two of 20 coyotes (10.0 per cent) in eastern Colorado. No heartworms were found in 61 specimens in Minnesota (Erickson, 1944), in 75 from Alberta (Holmes and Podesta, 1968) or in 43 examined in Manitoba (Samuel et al., 1978). In marked contrast, an incidence of 37 per cent was found in 115 coyotes in El Dorado County in California (Weinmann and Garcia, 1980) and 71 per cent in 24 specimens in coastal Louisiana and Texas (Custer and Pence, 1981).

Four cases of canine distemper were diagnosed. Trainer and Knowlton (1968) presented serologic evidence that 11 of 33 coyotes in Texas had probably contracted canine distemper and survived. Although clinical cases of distemper have been reported in captive coyotes (Gier et al., 1978), the diagnoses made in the present study appear to be the first reported in free-ranging coyotes.

Two unusual conditions were recorded. One coyote, apparently held in captivity at some time, was found debilitated by an undersized choke-chain collar (Monson and Stone, 1974). A case of severe metritis was observed in a female coyote shot by a farmer in April after it appeared unable to rise on his approach. Healthy week-old pups were found in a nearby den.

These data suggest that shooting, trapping, highway accidents and sarcoptic mange are major causes of mortality among coyotes in New York. More specific evaluation of the significance of mange and the distribution of heartworms would require further research. Also, little is known concerning the morbidity and mortality factors that affect coyote pups.

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AN UNUSUALLY LONG-LIVED RED FOX

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Early in December 1982, a trapper reported (to Environmental Conservation Officer Carlton Gay) having taken a tagged female red fox that was in excellent condition and had both ear tags intact. Records showed that it had been tagged as a pup, with five others, in August 1974 during a study of the red fox in central New York (Tullar and Berchielli, 1980). When recaptured, it was 8 years and 6 months old and had moved, and apparently settled, 10 miles west of the original capture point. Only one of the five others tagged at the same time has been recovered, and the present specimen may represent the longest documented survival of a red fox on record. Storm et al. (1976) reported that in Illinois and Iowa only one of 786 red foxes tagged as juveniles survived 6 years. They also reviewed the findings of other fox studies in America and Europe and found no record of a tagged red fox that had survived for more than 6 years in the wild. This unsolicited cooperation on the part of a trapper and the fact that there are still 357 unaccounted for tagged red foxes in central New York are grounds for hope that an even older individual may be encountered in the future.

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ESTIMATING THE HARVEST OF DEER IN NEW YORK BY SAMPLING HUNTER REPORTS[1]

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The harvest of deer in New York each year is calculated from report cards returned by hunters who take deer.[2] The totals are compiled by town, as well as by deer management unit. These statistics are used to derive quotas for taking antlerless deer for population control (Dickinson, 1982). The present study was undertaken to assess the reliability of harvest estimates derived by sampling the reports.

Reports for 31 deer management units in the Southern Zone in 1980 were used. In that year deer were hunted on these areas under both a regular big game license (including bowhunting and muzzleloading provisions) and a deer managment permit. Complete, separate files were compiled in the usual manner (i.e., by license serial number) for the deer reported taken under each. For the study, four series were selected from each of the two files. Three were obtained by taking every tenth record using different starting points, while the other was obtained by using every fifth record. All starting points were chosen at random. These series were then paired (one regular license file and one permit file) to produce four samples (Figure 1) for comparison with the total tabulation of all records.

The total tabulation served as the control for evaluating the samples, and the figures were calculated in the usual manner. As part of the usual procedure, a correction factor (Severinghaus, 1954) is applied to the number of deer actually reported to compensate for those taken but not reported. Values for this factor, for the two license types and for three regions of the State, are determined annually by recording the license numbers and permit numbers of some 16,000 successful hunters whose deer are examined at checking stations, freezer lockers and other locations across the State and then comparing them with the report cards returned. The proportion who report generally falls between 55 and 80 per cent. After this adjustment, the calculated kill is separated by age (adult and fawn) and by sex within each age group. All deer taken under a big game license without a stamp are assumed to be adult males. For those taken under a deer management permit, the age and sex distribution is based on the regional ratios recorded among the deer examined at checking stations etc. For deer taken under a bowhunting or muzzleloading stamp, the distribution is based on historical ratios[3]. The calculated kill is compiled according to town for deer taken under a big game license (including stamps) and according to management unit for those taken under a deer management permit. Finally, the data derived from big game licenses are reapportioned to represent deer management units.

The samples were treated similarly. However, separate correction factors were obtained for each sample by comparing the specific reports in that sample with the file representing deer known to have been taken. In each case, the ratio between the correction factor and that for the control was roughly the same as the ratio between the numbers in the two groups. Thus a deterministic model suggests that the deer kill calculated from the samples should closely match the control tabulation.

To assess the validity of this model, the number of the 31 management units for which the kill calculated from the samples differed from the control figure by less than 5 per cent (of the

[1]A contribution of New York Federal Aid in Fish and Wildlife Restoration Project W-126-R. The author acknowledges the assistance of Charles Dente, Sue Wolfe and Lawrence Alber for making calculations, James Powers for consultation on statistics and William Sarbello, Michael Hall, Robert Gotie, Gerald Rasmussen, Randall Stumvoll and Terrance Moore for reviewing the manuscript.

[2]A report card is part of each big game license and each deer management permit issued. By law, the holder of a big game license must return the report card if he takes a deer, while the holder of a permit must send in the card whether he takes a deer or not. A big game license entitles the holder to take one deer during the open season; this must be an antlered buck if taken pursuant to such license only, but it may be a deer of either sex or any age if the license has affixed to it a bowhunting or muzzleloading stamp. A deer management permit entitles the holder to take a deer of either sex or any age within a specified area, and this may be in addition to a deer taken under his big game license.

[3]For each hunting method in a given region, the average ratio over a period of years among the deer examined that had been taken by that method. The specific period used for the average is continually advanced.

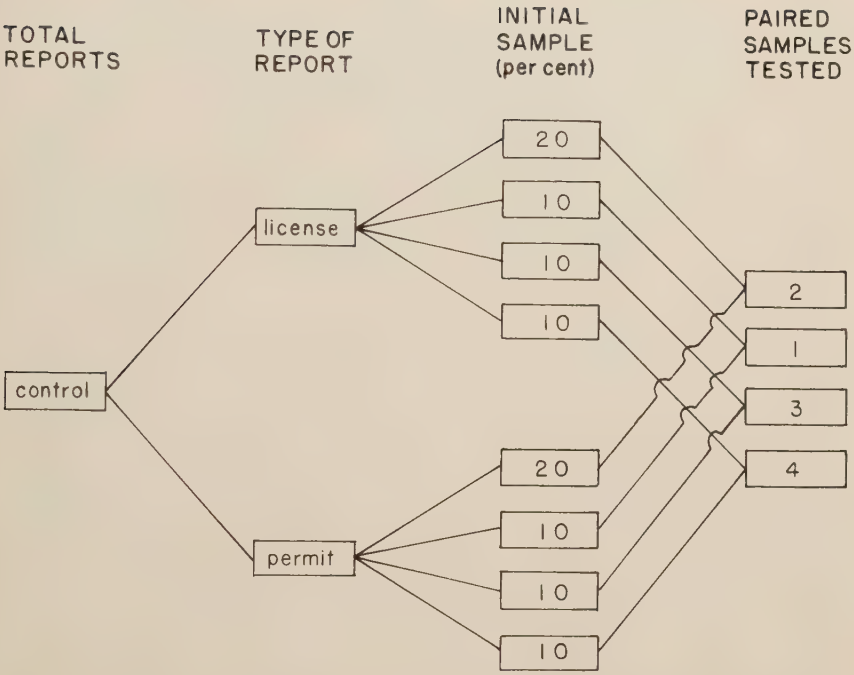

Figure 1. Manner in which the four samples of reports of deer taken were derived.

control figure), and the number that differed by less than 10 per cent, were determined. The results are summarized in Table 1. The 20 per cent sample (#2) gave the best estimates at both levels of tolerance, 29 of the 31 units being within 10 per cent and 23 units within 5 per cent of the control figure. The differences for the two units (82 and 86) that did not "qualify" at the 10 per cent level were 12.9 and 12.8 per cent, respectively. Also, for each management unit, the number of the three 10 per cent samples that gave estimates within 5 per cent and the number that gave estimates within 10 per cent were tabulated (Table 2).

In addition to a record of the annual harvest, certain other data concerning the deer taken are used for calculating deer management permit quotas, i.e., the number of bucks taken per square mile of deer range and the number of adult females taken per adult male. Values for these parameters for each of the 31 deer management units were derived for each sample and for the control group. Then the number of units for which the sample values differed from the control by less than 0.2 per square mile for the bucks taken, and the number for which the sample differed by less than 0.05 for the adult females per adult male, were determined. The

Table 1. For Each of the Four Samples, the Number of Deer Management Units For Which the Calculated Estimate Fell Within Specified Tolerance Limits With Respect to the Total Deer Kill, the Number of Bucks Taken Per Square Mile and the Number of Females Taken Per Male

Item	Tolerance§	Sample*			
		1	2	3	4
Total kill	5 per cent	13	23	21	12
Total kill	10 per cent	24	29	26	23
Bucks per square mile	0.2 buck	13	20	13	8
Females per male (adult)	0.05 female	15	23	16	15

*According to Figure 1; No. 2 was a 20 per cent sample, the others 10 per cent.

§Maximum difference between sample and total tabulation.

Table 2. For Each Deer Management Unit, the Number of the Three 10 Per Cent Samples That Gave Estimates Within the Specified Tolerance Limits For the Factors Considered

Unit	Factor and tolerance limit			
	Total kill		Bucks per square mile (0.2)	Females per male (0.05)
	5 per cent	10 per cent		
41	3	3	1	1
42	2	3	1	2
43	0	3	0	1
44	1	1	0	0
45	2	2	2	2
48	0	3	1	1
51	1	2	1	3
52	2	3	2	0
54	2	3	1	1
57	1	3	1	2
58	2	2	1	2
60	1	3	1	2
62	2	2	2	1
64	1	2	1	1
68	3	3	1	2
71	2	2	0	1
74	1	3	2	2
75	2	3	2	3
76	2	2	1	2
78	2	3	1	2
82	1	1	1	0
86	1	3	2	2
87	3	3	2	2
88	2	3	1	0
89	1	1	0	2
90	3	3	1	2
91	1	1	1	0
93	1	1	1	2
94	3	3	1	2
95	0	2	1	3
97	0	1	1	0

results are included in Table 1. The estimates obtained by sampling were less representative for these parameters than for the total harvest. In the 20 per cent sample, only 20 of the units were within the tolerance limits for bucks taken per square mile, while for females per male the number of units was 23. The numbers of the three 10 per cent samples that were within these limits for each unit are included in Table 2.

In general, sampling at a rate of 20 per cent produced estimates of deer harvest parameters that were within the specified tolerance limits for about two-thirds of the 31 management units considered. The estimates were most like the control figures with respect to the total kill, but less representative for bucks taken per square mile and for females taken per male.

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AN EXAMPLE OF THE EFFECT OF UNDERHARVESTING ON A DEER POPULATION[1]

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During the fall of 1981 a 16-square-mile tract of Bear Mountain-Harriman State Park was opened to deer hunting. This was the first time that such hunting had been permitted in any part of the Park during its 71-year history[2]. The harvested white-tailed deer (*Odocoileus virginianus*) that were examined were the poorest specimens, in physical condition, ever recorded in New York and possibly in the Northeast.

The Park, an area of some 52,000 acres, straddles the boundary between Rockland and Orange Counties and is situated in the Hudson Highlands section (Dickinson, 1979) of southeastern New York. The area opened to deer hunting was in the southern half of the Park and near its eastern boundary. The lands to the east and south of this boundary afford largely marginal deer habitat, and consequently deer have been scarce and little hunted. To the west and north, several miles of Park territory separated most of the opened area from lands where deer had been hunted each year.

The absence of any effective deer population control on the Park had led to the virtual elimination of practically all the woody plant species that normally occur in the understory (Cobb, 1982). A state of chronic malnutrition among the deer had resulted. In 1981 a recommendation calling for regulated deer harvests was initiated by the Palisades Interstate Park Commission and endorsed by the State Departments of Parks and Recreation and Environmental Conservation. However, it was decided to take a "go slow" approach because of conflicts with other uses of the Park and significant public opposition (Cobb, 1982). For the 1981 season a total of 350 hunters were allowed in the open area. One deer with at least one antler 3 inches or more in length could be taken on a regular big game license, and an additional deer of either sex or any age could be taken on a deer management permit.

A total of 77 deer were legally harvested. They were examined at a checking station operated by personnel from both departments. Dressed weight (all internal organs removed) was recorded, by age as determined according to Severinghaus (1949), for 35 males and 25 females. The data are summarized in Table 1 together with corresponding average figures for other regions of the State as given by Severinghaus (1979). It is apparent that the weights of the deer from Harriman State Park were much lower for all age groups than those for the other regions, even those for the central Adirondacks which represents some of the poorest

Table 1. Weight of Deer From Harriman State Park in 1981 Compared with Averages For Other Regions of New York, According to Age*

Age (years)	Mean dressed weight (pounds)			
	Harriman State Park§	Central Adirondacks	Central Catskills	Western New York
		Male		
½	42 (4)	54	55	74
1½	67 (12)	91	96	119
2½ +	94 (19)	143	129	158
		Female		
½	40 (5)	51	50	70
1½	67 (4)	79	85	108
3½ +†	73 (16)	93	100	115

*Data for other regions from Severinghaus (1979).

§Figures in parentheses represent number of specimens.

†There were no 2½-year-old females; all those older than yearlings were 3½ years or over.

[1]A contribution of New York Federal Aid in Fish and Wildlife Restoration Project W-89-R.

[2]This Park was established in 1910, and additions since then have been minor. Most of Harriman Park had been the private estate of the family of Edward H. Harriman and had not been open to public hunting for many years prior to that date.

Table 2. Antler Beam Diameter of Male Deer From Harriman State Park in 1981 Compared With Averages For Other Regions of New York, According to Age*

Age (years)	Mean diameter (millimeters)§				
	Harriman State Park‡	Adirondacks	Catskills	Southern Tier	Lake Plains
1½	12.3 (10)	17.1	16.9	19.0	20.8
2½	22.0 (2)	21.9	21.7	24.7	27.5
3½ +	22.9 (17)	29.9	24.3	27.7	31.1

*Data for other regions from unpublished records of Federal Aid Project W-89-R.

§Measured 1 inch above base of the burr.

†Figures in parentheses represent number of specimens.

deer range in the State where overbrowsing and mortality from malnutrition are chronic. In most of the central Catskills, also, the deer population has continually exceeded the carrying capacity of the winter range. On the other hand, the range in central and western New York produces some of the finest deer in the State.

Antler beam diameter is a reliable index of the physical condition of deer (Severinghaus and Moen, 1983). These data for 29 males taken in Harriman State Park are summarized in Table 2 together with corresponding average figures for other regions of the State as derived from unpublished records of the Department. Compared with those from the other areas, the antlers of deer from the Park were generally smaller, the difference being greatest among the yearlings. There were also two yearlings (not included in the table) that did not produce 3-inch antlers. Although there was less difference for the 2½ year olds, only two males from the Park were in that age group.

The age composition of the deer taken was typical of an unexploited population subject to chronic malnutrition. Of the 31 adult males, 39 per cent were yearlings and 55 per cent were 3½ years old or older, the oldest being 7½ years. Of the 20 adult females, the corresponding proportions were 20 and 80 per cent, respectively (there were no 2½ year olds). A few females were over 10 years old. The population had obviously been subject to a low rate of turnover with a low recruitment of young animals.

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RELATION OF WINTER SEVERITY TO NUMBER AND AGE COMPOSITION OF BUCK DEER TAKEN BY HUNTING IN THE ADIRONDACKS[1]

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Sauer and Severinghaus (1983) presented data demonstrating a positive correlation between the relative winter mortality of deer from year to year in the Adirondacks and the severity of the winter as indicated by the number of days with snow depths of 20 inches or more. At the same time, there was a negative correlation between the duration of critical snow depths and the legal harvest of bucks in this region. The buck take in a given year was significantly correlated with the number of critical snow days for both the immediately preceding winter ($r = -0.820$, $P < 0.01$) and the winter before that ($r = -0.647$, $P < 0.01$). Based on the number of bucks taken (BT) each year from 1956 to 1970 and the number of critical snow days for the two preceding winters in each case (X_1 and X_2), a multiple regression accounted for 84 per cent of the variation in the take ($r = 0.919$, $P < 0.01$). The regression equation was

$$BT \pm 732 = 12{,}600 - 38.47X_1 - 27.71X_2$$

The recorded buck take versus the take derived from the equation is shown in Table 1 and

TABLE 1. CALCULATED BUCK TAKE AND NUMBER OF CRITICAL SNOW DAYS IN THE ADIRONDACK REGION FROM 1955 TO 1970, TOGETHER WITH THE PREDICTED TAKE DERIVED FROM CORRELATION OF THE CALCULATED TAKE WITH SNOW DEPTHS DURING THE PRECEDING TWO WINTERS

Year*	Calculated buck take§	Number of critical snow days§	Predicted buck take§
1955	. .	58	. .
1956	9,575	55	8,877
1957	10,733	7	10,807
1958	10,199	48	10,559
1959	8,526	81	8,154
1960	8,615	82	7,200
1961	8,532	25	9,366
1962	9,359	47	10,099
1963	8,428	76	8,374
1964	8,814	38	9,032
1965	11,382	17	10,893
1966	10,915	23	11,244
1967	12,041	24	11,040
1968	10,751	25	10,973
1969	7,979	94	8,291
1970	5,094	103	6,033

*Represents spring of each overwinter season.

§The calculated take is the reported take adjusted to account for the number of successful hunters who do not return their report cards. Values apply to fall; therefore the number of critical snow days given for the same year represents the first prior overwinter season.

†From Sauer and Severinghaus (1983).

Figure 1. The relationship involves two winters because mortality among females two years prior determines the size of the reproductive segment of the population and the winter one year prior influences the mortality of fawns born to these females.

Since fawns are the age group most susceptible to winter mortality, there was a correlation ($r = -0.679$, $P < 0.01$) between the number of critical snow days during the winter prior to

[1]A contribution of Federal Aid in Fish and Wildlife Restoration Project W-89R.

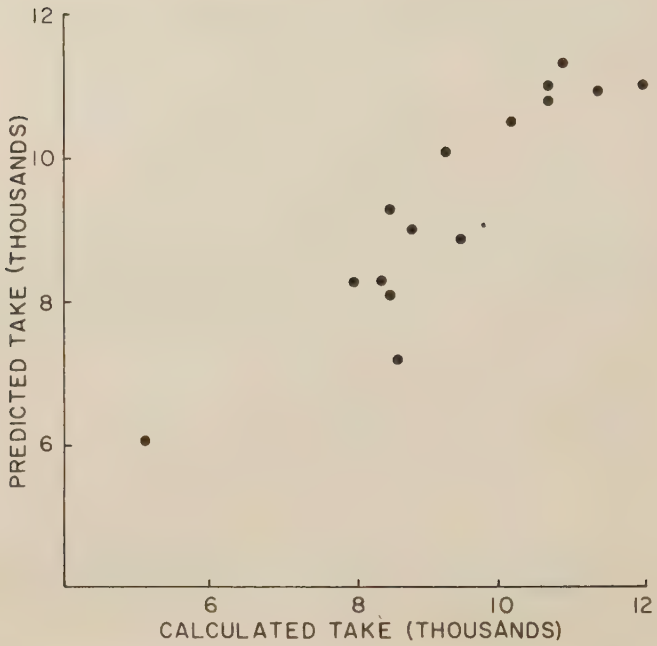

Figure 1. Calculated buck take in the Adirondack region versus the take as predicted from the number of critical snow days for the two winters prior to the harvest, 1956-1970.

a given harvest and the frequency of yearling males in that harvest (YT). The regression equation was

$$YT \text{ (as percentage)} \pm 5.14 = 36.94 - 0.149X_1$$

Similarly, there was a significant correlation ($r = -0.585$, $P < 0.05$) between the number of critical snow days during the winter two years prior to a given harvest and the frequency of 2½-year-old males in that harvest (ST). The regression equation was

$$ST \text{ (as percentage)} \pm 2.54 = 30.42 - 0.065X_2$$

The result of these two relationships is a "dog leg" in the age composition (i.e., fewer yearling males than 2½-year-old males) whenever a moderate-to-severe winter follows a mild winter regardless of population size. Two severe winters in succession would have the same effect.

Assessment of mortality is essential to the management of deer populations. In formulating hunting regulations to achieve the desired population control, biologists must take into consideration all other losses one of which is winter mortality. Dead deer surveys are inadequate as a means of measuring winter mortality for this purpose (Sauer and Severinghaus, 1983). A promising alternative involves modeling starvation losses on the basis of physiological and climatological data. The correlations described here between the duration of critical snow depths and the number and age composition of the buck take are important elements of such modeling.

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HARVEST AND ATTITUDES OF NON-RESIDENT TRAPPERS IN NEW YORK

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To explore the motives and rewards of non-resident trappers in New York, a short questionnaire was sent to 26 such individuals who paid the $200 fee during the 1981-82 season. The following questions were asked.

1. How many days did you trap in New York State
2. In what counties did you trap
3. What species did you trap for and how many of each did you take
4. What other states did you trap in
5. What problems did you have
6. Did you sell your fur to a New York State fur buyer
7. Did you buy fur in New York State

Eleven of those to whom the questionnaire was sent responded. One other reported that he was unable to leave his home state but had trapped in New York in previous years. There was no follow-up effort with respect to those who did not respond.

Nine of the respondents were from Pennsylvania, one was from Alaska and one was from Quebec. None had trapped in the Adirondacks, although the Quebec resident trapped in Franklin County along the Canadian border. The others trapped in the southern and western counties of Allegany, Broome, Cattaraugus, Chautauqua, Chemung, Delaware, Steuben, Sullivan, Tioga, Wayne and Westchester. Some reported that they had also trapped in Colorado, North Carolina and Wisconsin in addition to their home state or province.

The information furnished by the respondents who trapped in New York in 1981-82 is summarized in Table 1. It is of interest that raccoons were sought and taken by all these trappers, while muskrats were taken in the greatest number. One trapper apparently was a muskrat specialist who also caught an occasional mink and raccoon. Skunks and opossums were not actually sought, but were inadvertently caught by four trappers who, presumably, skinned and sold them. It is possible that some of the other trappers caught these species but simply released them. Both red foxes and gray foxes were sought by nine of the respondents.

To estimate the value of the catch, a conservative per-pelt value was used for each species. Assuming that all of the furbearers taken were pelted and sold, the estimated total received by the trappers for the harvested fur was $11,959. Deducting the $2,200 paid in license fees leaves a net income of $9,759 for which the trappers had worked 394 days, or an average of $25 per day (range $6 to $56). Six trappers sold all or part of their fur in New York State. None reported buying fur in the State.

Problems encountered by the respondents seem to have been minor. Three reported fur or traps stolen, and two thought that night hunters had reduced their catches. Three trappers stated that they had no problems, and two praised houndsmen who had left raccoons lying beside traps after their dogs had killed them. One praised environmental conservation officers for being courteous and helpful. Only one, the twelfth respondent, who did not trap in the State, complained that the license fee was too high although he acknowledged that the non-resident fee charged by his home state was even higher.

It is widely believed that profit is the chief motive for trapping, especially for those who pay the high fees for non-resident licenses. For the respondents in this survey, their work cannot be considered to have been highly profitable, even for the most productive trapper. For most, trapping appears to be an avocation that only pays for some or possibly most of the expenses that the activity requires. Except for the man who took 115 furbearers in 42 days and netted an average of $56 per day, adventure and recreation seemed to be the primary reward. Many of their unassembled comments also indicated that money was not a primary motive for trapping, and some were outspokenly grateful for having enjoyed the privilege in spite of the high cost.

Table 1. Number of Furbearers Taken, Time Spent and Value of Catch For 11 Non-resident Trappers in New York in 1981-82

Species	Responding trappers*												Value (dollars)	
	1	2	3	4	5	6	7	8	9	10	11	Total	Per pelt§	Gross
Muskrat	12	. .	282	22	300	60	27	. .	. .	. .	. .	703	3	2,109
Raccoon	32	10	31	43	10	25	12	10	43	20	18	254	10	2,540
Red fox	. .	8	17	1	. .	10	17	17	2	50	12	214	20	4,280
Opossum	. .	. .	. .	50	. .	. .	. .	20	29	. .	30	129	1	129
Gray fox	. .	12	22	2	. .	1	9	8	5	9	18	86	20	1,720
Mink	. .	. .	43	17	2	11	1	. .	. .	. .	2	76	10	760
Skunk	. .	. .	. .	23	. .	. .	. .	10	5	. .	15	53	2	106
Beaver	. .	. .	1	. .	. .	. .	. .	. .	. .	. .	20	21	15	315
Total	44	30	476	158	312	107	66	65	84	79	115	1,536	xxx	11,959
Net value (dollars)†	156	300	3,781	622	820	560	531	440	409	1,180	960	9,759	xxx	xxx
Trapping days	12	14	116	21	30	90	17	17	14	21	42	395	xxx	xxx
Income per day (dollars)‡	13	21	33	30	27	6	31	26	29	56	23	25	xxx	xxx

*Indicated by number for convenience.

§Conservative values.

†Total fur value minus the $200 license fee.

‡Rounded to nearest dollar.

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